ARM-97-001

Site Scientific Mission Plan for the Southern Great Plains CART Site

January-June 1997

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Environmental Research Division
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CONTENTS

FIGURES

TABLES

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NOTATION

ABLE	Argonne Boundary Layer Experiment
ABRFC	Arkansas Basin Red River Forecast Center
AERI	atmospherically emitted radiance interferometer
AMMR	advanced multispectral microwave radar
ANL	Argonne National Laboratory
AOS	aerosol observation system
ARESE	ARM Enhanced Shortwave Experiment
ARM	Atmospheric Radiation Measurement
ASTER	air-surface turbulence exchange research
ASTI	absolute solar transmittance interferometer
AVHRR	advanced very-high-resolution radiometer
AWS	automated weather station
BAMS	*Bulletin of the American Meteorological Society*
BBSS	balloon-borne sounding system
BF	boundary facility
BLC	Belfort laser ceilometer
BLX	Boundary Layer EXperiment
BORCAL	Broadband Outdoor Radiometer CALibration
BRS	broadband radiometer station
BSRN	Baseline Surface Radiation Network
CAR	Corrective Action Report
CART	Cloud and Radiation Testbed
CASES	Cooperative Atmosphere-Surface Exchange Study
CASH	commercial aviation sensing humidity
CCN	cloud condensation nuclei
CERES	Clouds and Earth's Radiant Energy System
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies
CIMSS/SSEC	Cooperative Institute for Meteorological Satellite Studies/Space Science and Engineering Center
CIRA	Cooperative Institute for Research in the Atmosphere
CLASS	cross-chain loran atmospheric sounding system
CLEX	Cloud Layer EXperiment
CSPHOT	Cimel sunphotometer
CSU	Colorado State University
DIAL	DIfferential Absorption Lidar
DOE	U.S. Department of Energy
DQR	Data Quality Report
DSIT	Data and Science Integration Team
EBBR	energy balance Bowen ratio
ECMWF	European Centre for Medium Range Weather Forecasts
ECOR	eddy correlation
EF	extended facility
ETL	Environmental Technology Laboratory
FDDA	four-dimensional data assimilation

FTP	file transfer protocol
GCIP	GEWEX Continental-Scale International Project
GCM	general circulation model
GEWEX	Global Energy and Water Cycle Experiment
GIST	GEWEX Integrated System Test
GOES	geostationary orbiting Earth satellite
GPS	global positioning system
GSFC	Goddard Space Flight Center
GVFA	geophysical variable focus area
IDP	Instrument Development Program
IF	intermediate facility
IOP	intensive observation period
IPM	instrument performance model
IR	infrared
IRF	instantaneous radiative flux
IRT	infrared thermometer
ISLSCP	International Satellite Land-Surface Climatology Project
ISM	Integrated Surface Mesonet
ISS	integrated sounding system
IT	Instrument Team
KSU	Kansas State University
LANL	Los Alamos National Laboratory
LBL	line by line
LBLRTM	line-by-line radiative transfer model
LLJ	Low-Level Jet
LMS	Lockheed Missile and Space
MAPS	Mesoscale Analysis and Prediction System
MFR	multifilter radiometer
MFRSR	multifilter rotating shadowband radiometer
MIR	microwave imaging radar
MMCR	millimeter cloud radar
MPL	micropulse lidar
MSU	Millersville State University
MSX	Midcourse Satellite Experiment
MWR	microwave radiometer
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NCSU	North Carolina State University
NEPA	National Environmental Policy Act
NEXRAD	next-generation radar
NGM	nested grid model
NIP	normal-incidence pyrheliometer
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NREL	National Renewable Energy Laboratory

NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OCS	Oklahoma Climatological Survey
OKM	Oklahoma Mesonet
ORR	Operational Readiness Review
OU	University of Oklahoma
PAR	photosynthetically active radiometer
PARABOLA	portable appartus for rapid acquisition of bidirectional observations of the land and the atmosphere
PARC	Palo Alto Research Center
PBL	planetary boundary layer
PC	personal computer
PIF	Problem Identification Form
PNNL	Pacific Northwest National Laboratory
PRB	Problem Review Board
PRR	Pre-Readiness Review
PSU	Pennsylvania State University
QME	quality measurement experiment
RASS	radio acoustic sounding system
RCF	radiometer calibration facility
RLID	Raman lidar
RSS	rotating shadowband spectral
RUC	rapid update cycle
RWP	radar wind profiler
S	solar
SAC	Site Advisory Committee
SCM	single-column model
SDS	site data system
SGP	Southern Great Plains
SI	International System of Units
SIROS	solar and infrared radiation observing system
SIRS	solar and infrared station
SITAC	Spectral Imagery Technology Applications Center
SMOS	surface meteorological observation station
SNL	Sandia National Laboratories
SORTI	solar radiance transmission interferometer
SST	Site Scientist Team
SUCCESS	Subsonic Aircraft: Contrail and Cloud Effects Special Study
SVC	sky video camera
SWATS	soil water and temperature system
TBD	to be determined
T/RH	temperature and relative humidity sensor
TWP	Tropical Western Pacific
UAV	unmanned aerospace vehicle
UBC	University of British Columbia
UIR	upwelling infrared radiometer

UM	University of Massachusetts
UNAVCO	University NAVSTAR Consortium
UoM	University of Maryland
USDA	U.S. Department of Agriculture
USR	upwelling solar radiometer
UTC	universal time coordinated
UU	University of Utah
UV-B	ultraviolet B
UW	University of Wisconsin
VAPs	value-added products
Vceil	Vaisala ceilometer
VORTEX	Verification of the Origins of Rotation in Tornadoes Experiment
WPDN	Wind Profiler Demonstration Network
WPL	Wave Propagation Laboratory
WSI	whole-sky imager

SITE SCIENTIFIC MISSION PLAN
FOR THE SOUTHERN GREAT PLAINS CART SITE
JANUARY-JUNE 1997

1 INTRODUCTION

The Southern Great Plains (SGP) Cloud and Radiation Testbed (CART) site is designed to help satisfy the data needs of the Atmospheric Radiation Measurement (ARM) Program Science Team. This document defines the scientific priorities for site activities during the six months beginning on January 1, 1997, and looks forward in lesser detail to subsequent six-month periods. The primary purpose of this *Site Scientific Mission Plan* is to provide guidance for the development of plans for site operations. It also provides information on current plans to the ARM functional teams (Management Team, Data and Science Integration Team [DSIT], Operations Team, Instrument Team [IT], and Campaign Team) and serves to disseminate the plans more generally within the ARM Program and among the members of the Science Team. This document includes a description of the operational status of the site and the primary site activities envisioned, together with information concerning approved and proposed intensive observation periods (IOPs). The primary users of this document are the site operator, the Site Scientist Team (SST), the Science Team through the ARM Program science director, the ARM Program Experiment Center, and the aforementioned ARM Program functional teams. This plan is a living document that is updated and reissued every six months as the observational facilities are developed, tested, and augmented and as priorities are adjusted in response to developments in scientific planning and understanding.

This report is available on the SGP CART site World Wide Web home page at

http://www.arm.gov/docs/sites/sgp/sgp.html

under the heading "Site Scientific Mission Plan."

2 SUMMARY OF SCIENTIFIC GOALS

2.1 Programmatic Goals

The primary goal of the SGP CART site activities is to produce data adequate to support significant research addressing the objectives of the ARM Program. These overall objectives, as paraphrased from the *ARM Program Plan, 1990* (U.S. Department of Energy 1990), are the following:

- To describe the radiative energy flux profile of the clear and cloudy atmosphere

- To understand the processes determining the flux profile

- To parameterize the processes determining the flux profile for incorporation into general circulation models (GCMs)

To address these scientific issues, an empirical data set must be developed that includes observations of the evolution of the radiative state of the column of air over the central facility, as well as the processes that control that radiative state, in sufficient detail and quality to support the investigations proposed by the ARM Science Team. To address the entire 350-km × 400-km SGP CART site, the ARM Program relies on models to compute the processes or properties that affect radiative transfer. This set of data includes measurements of radiative fluxes (solar and infrared [IR]) and the advective and surface fluxes of moisture, heat, and momentum occurring within the column and across its boundaries. Other entities to be described are cloud types, composition, and distribution (depth, fractional coverage, and layering); thermodynamic properties of the columnar air mass (temperature, pressure, and concentrations of all three phases of water); the state and characteristics of the underlying surface (the lower boundary condition); processes within the column that create or modify all of these characteristics (including precipitation, evaporation, and the generation of condensation nuclei); and radiatively significant particles, aerosols, and gases. Basic continuous observations must be made as often as is feasible within budgetary constraints. For limited periods of time, these observations will be supplemented by directed IOPs providing higher-resolution or difficult-to-obtain *in situ* data.

Beyond simply providing the data streams, determining their character and quality as early as possible in the observational program is imperative. This evaluation will provide the basic operational understanding of the data necessary for an ongoing program of such scope. Although both reason and ample opportunity will exist to develop a further understanding of the ARM observations over the course of the program, the task of investigating and ensuring the data quality is extremely important. In this regard, definitive quality measurement experiments (QMEs) will help establish confidence in the measurements.

The SGP CART site is the first of several global locations chosen and instrumented for data collection. As summarized in the *Science Plan* for the ARM Program (U.S. Department of Energy 1996), the scientific issues to be addressed by using data from a midlatitude continental CART observatory include the following:

- Radiative transfer in cloudless, partly cloudy, and overcast conditions

- Cloud formation, maintenance, and dissipation

- Nonradiative flux parameterizations

- The role of surface physical and vegetative properties in the column energy balance

- Other complications in the radiative balance in the atmosphere, particularly those due to aerosols, cloud condensation nuclei (CCN), and cloud-aerosol radiative interactions

- Feedback processes between different phenomena and different domains

The variety, surface density, and atmospheric volumetric coverage of the SGP instrumentation will be more comprehensive than those at any other ARM site, and the SGP site will experience a wider variety of atmospheric conditions than will any other ARM site. The resulting data will accordingly support a greater range and depth of scientific investigation than data from any other location, making it imperative for the ARM Program to develop and maintain a high-quality, continuous data stream from the SGP site.

The measurements required by Science Team proposals, the DSIT, and the science director are incorporated into geophysical variable focus areas (GVFAs). The DSIT and other teams coordinate activities to develop these integrated, well-focused data sets. The GVFAs include shortwave radiation, water vapor, longwave radiation, aerosols, clouds, surface fluxes, and the single-column model (SCM). A goal is to facilitate algorithm development that prescribes geophysical phenomena as products of multiple data streams rather than focusing on individual data streams.

2.2 Priorities for Site Activities

With the construction of the SGP CART site nearing completion, the primary scientific goal has shifted from the establishment of routine observations to addressing the specific science issues related to the site. In descending order, we rank the priorities of site activities for January through June 1997 as follows:

1. Support all data quality assurance efforts, particularly those focused on shortwave radiation, including implementation of QMEs and value-added products (VAPs).

2. Complete establishment and sustain high quality of routine site operations.

3. Plan and implement key IOPs and campaigns.

4. Finish implementation of extended facilities.

5. Support the Instrument Development Program (IDP).

Within this ranking, the differences in relative importance between adjacent items are not large. The categorization is also somewhat artificial because many site activities have multiple purposes. For example, IOP activities can simultaneously support Science Team, IDP, and campaign requirements. Even so, this ranking reflects our scientific assessment of the activities that should receive the most support during this period.

The IOPs focus on providing critical data sets on an episodic basis to the Science Team, as well as field support for instrument development and testing and for collaborative campaigns. The IOPs scheduled for this six-month period are detailed in Section 5.1.

To assist the site scientist with scientific issues, a Site Advisory Committee (SAC), consisting of seven scientists (approximately half from outside the ARM Program), provides scientific guidance for the SGP CART site. The SAC works directly with the site scientist and the site program manager. A report from a meeting held on June 11 and 12, 1996, in Norman, Oklahoma, will become available during this six-month period. That meeting followed up on the first SAC meeting (November 27-29, 1995) that included a visit to the SGP CART site.

Routine radiosonde observations will continue to include five daily balloon-borne sounding system (BBSS) launches on Monday through Friday (including holidays) at the central facility. One routine daily launch will continue on Monday through Friday (including holidays) at the four boundary facilities. Three SCM IOPs, each lasting for three weeks, are now conducted each year. Spring and summer SCM IOPs are scheduled annually, while fall and winter SCM IOPs alternate between years. An SCM IOP is scheduled for fall 1997. The first of at least three Water Vapor IOPs was successfully conducted in September 1996 at the central facility. This IOP series will help define the water vapor properties above the SGP CART site, especially in the lowest few hundred meters to a kilometer, a critical need of the Instantaneous Radiative Flux (IRF) Working Group, one of several Science Team working groups. See Section 5.1 for more details.

Although more instrumentation can always be added, the SGP site central facility and boundary facilities are basically complete as originally planned, and routine operations have been established for most platforms. Operation of the radiometer calibration facility has started, with personnel from the National Renewable Energy Laboratory (NREL) currently performing most of the work. Although plans for overall operation of this facility are being formulated, successful calibration was first carried out in September 1996. The emphasis on deployment in this six-month period will be on completing the installation of the remaining extended facilities (Okmulgee, the wooded site; and Ft. Cobb, an eddy correlation [ECOR] site) and possibly implementing one auxiliary facility. In addition, a Memorandum of Understanding with the U.S. Department of Agriculture (USDA) in support of Global Energy and Water Cycle Experiment (GEWEX) studies will allow the costs of installation to be shared with ARM, and phased implementation of a fully instrumented extended facility at El Reno is to begin this spring. This energy balance Bowen ratio (EBBR) site will be in support of the SGP '97 (Hydrology) IOP and continued research efforts by the USDA.

Although budgetary limitations have somewhat slowed the development and completion of the site, 24 permanent extended facilities will be in place at the end of this six-month period. The forested Okmulgee site should be completed in 1997. The Seminole site was completed in December 1996, while a new site at El Reno, to be constructed in part for the SGP '97 IOP, will be completed during this six-month period. The disposition of the ECOR-based Ft. Cobb is yet to be determined. Establishment of one auxiliary facility will be needed to accommodate the installation of a second day-night whole-sky imager (WSI). During the last six-month period, 915-MHz profilers with radio acoustic sounding systems (RASSs) were deployed at locations between the central and boundary facilities; these locations are known as intermediate facilities. These profilers will enhance the boundary layer monitoring across the SGP CART site.

The IDP millimeter cloud radar is expected to become a CART instrument during this six-month period. In addition, a solar light ultraviolet B (UV-B) radiometer, a photosynthetically active radiation sensor, a Vaisala 75-km ceilometer, a whole-sky cloud video camera, four Vaisala 25-km ceilometers and four atmospherically emitted radiance interferometers (AERIs), and a Cimel sunphotometer (CSPHOT) are expected to complete the process of Pre-Readiness Review (PRR) and Operational Readiness Review (ORR) and become CART instruments sometime during the next six months.

A unique opportunity to supplement the existing CART instrumentation was proposed by the SST and has been funded by the GEWEX Continental-Scale International Project (GCIP), housed within the National Oceanic and Atmospheric Administration (NOAA) Office of Global Programs. This support has permitted sensors for the profiling of soil moisture and temperature to be installed at the central facility and the extended facilities during the last six-month period, with the network to be completed by the spring of 1997. These additional sensors will support water and energy budget analyses, diagnostic studies, and model validation efforts of ARM and GCIP investigators.

During IOPs, site operations staff will continue to support activities necessary for the IDP. Remaining IDP-related efforts will be dedicated to either configuring systems for permanent deployment at the CART site (e.g., the Valero radiometers, a rotating shadowband spectral [RSS] radiometer, and an AERI X) or evaluating the operational requirements for a few remaining instruments in need of field verification (e.g., the millimeter cloud lidar). These activities will continue during the next six months.

In summary, our goals for this six-month period are to provide the Science Team with a suite of measurements that will support a wide range of research, to establish solid procedures for instrument calibration and maintenance (particularly for broadband radiometry), to continue the series of QMEs, and to provide input for the GVFAs. Quality assurance efforts are central to the success of the entire program. Section 4 further describes this emphasis.

3 ROUTINE SITE OPERATIONS

3.1 Overview

The overwhelming majority of the measurements with the highest priority, on which the existing experimental designs are based, are regular (i.e., routine) observations, as specified in the *ARM Program Plan, 1990* (U.S. Department of Energy 1990). Scientifically and logistically, routine operations will also serve as the basis and background for all nonroutine operations, including instrument development activities, IOPs, and collaborative campaigns directed toward obtaining difficult-to-gather or expensive *in situ* data. Consequently, development and validation of the basic observations remain high priorities. Site development has progressed sufficiently to support IOPs addressing key scientific questions. The IOPs are an opportunity to provide more focused data sets to the Science Team and the scientific community at large.

The SST will continue to work to ensure the scientific productivity of the site by providing guidance to the site operations manager and his staff on scientific matters related to instrument performance via the quality of the data stream, by answering questions from operations personnel concerning potential instrument problems, by reviewing schedules and procedures for instrument maintenance and calibration, by reviewing designs for infrastructure supporting new instruments, by contributing to the design of the standard operating procedures, by reviewing and developing plans for IOPs, and by helping to obtain near-real-time data displays for IOPs. The SST, in cooperation with instrument mentors and the DSIT, will continue to lead the data quality control effort at the CART site, an ongoing activity that includes monitoring of the CART data streams in collaboration with the staff at the central facility and the development of quality assurance performance metrics and graphic tools that will address the data originating at the SGP site. A special focus during this six-month period will be on shortwave radiation data or anticipation of the Clouds and Earth's Radiant Energy System (CERES) launch in August 1997. These activities are discussed in more detail in Section 4 of this report.

Routine operations are considered to be the activities related to the operation and maintenance of instruments, the gathering and delivery of the resulting data, and the planning for scientific investigations, including IOPs, campaigns, and QMEs. Although the site is nearly complete, instrumentation will be evaluated continuously to assess the need for possible elimination of instruments or replacement with updated or new sensors. The process that leads to implementation of CART instruments continues to be the PRR. The PRR includes the identification of requirements for instrument design and installation and the development of the documentation, procedures, and training needed to maintain CART instrumentation and integrate data streams into the site data system (SDS). The PRR also provides a forecast of when these instruments will be fully operational and delivering data to the Experiment Center and the Archive.

The design expectation for the routine operation of instruments is that they will require servicing by site operators only once every two weeks. The exception to this is the central facility and the boundary facilities, which are staffed. If an instrument fails during a two-week period at an extended facility, data streams could be lost. Such loss of data is unfortunate but acceptable to the ARM Program because of manpower and budget constraints. The data collected at all extended and boundary facilities by the end of this period are expected to be polled frequently each day by the SDS at the central facility and then packaged and delivered to the Experiment Center and the Archive once daily. The Experiment Center generally delivers data to Science Team members and other data requesters once weekly.

Site operations staff conduct instrument triage during IOPs and campaigns. The triage plan calls for identifying instruments, individual sensors, and communication links that are critical to the operation and goals of the IOP and will receive more frequent servicing than that prescribed by routine operation requirements mentioned above. The priority of triage efforts is determined by the SST and IOP scientists and the site program manager, who take into consideration the scientific importance of a particular data stream and its expense. The triage plan has been very successful, as demonstrated during the recent IOPs for the ARM Enhanced Shortwave Experiment (ARESE), for the Subsonic Aircraft: Contrail and Cloud Effects Special Study (SUCCESS), and for the Water Vapor. The triage plan will continue to be an ongoing effort during the upcoming six months.

Handling of instruments that must be returned to the vendor for calibration and servicing is also part of routine operation. Replacement instruments and sensors will be rotated regularly to meet these requirements. Calibration and maintenance information is being compiled by the SST in conjunction with the site program manager, site operations manager, and instrument mentors in order both to properly operate and maintain site instruments and to provide pertinent information to data users. Changeouts of all sensors and instrumentation are recorded in the site operations log.

The initial checks on data quality after instrument installation are provided by the instrument mentors. After the mentor reviews the data stream to ensure that the acquired instrument is performing properly and that the data are identified accurately by the Experiment Center, the mentor approves a "beta" release of the data. The beta release provides data to selected Science Team members who have requested them and are willing to work with the instrument mentor on data quality issues. Beta releases are established after the instrument mentor and an appropriate member of the DSIT create a general statement on data quality for the Experiment Center. Beta releases are also available to other Science Team members who are willing to work in conjunction with the instrument mentor. When the data quality relative to proper instrument functionality is consistently acceptable and well documented, the mentor approves a full release of the data.

3.2 Routine Operations

3.2.1 Functional Instruments and Observational Systems

Accomplishments in the area of site development are most evident at the central facility (Table A.1 in Appendix A), with its functioning power, fiber-optic infrastructure, and near-complete array of instruments. Of the 26 planned extended facilities (Table A.2 in Appendix A), 22 (including 1 at the central facility and 1 at the Cement location) are operational at the beginning of this period (Seminole site completed sans EBBR sensors in December 1996), 1 (Okmulgee, the wooded site) is expected to be operational by the end of this six-month period, 1 (Ft. Cobb) is yet to be identified, 1 is a placeholder site for possible expansion, if required, and El Reno, previously on the original list of extended facilities but deleted for various reasons, will now be constructed with at least an EBBR and soil water and temperature system (SWATS) during this six-month period. This site is desired by the USDA and the National Aeronautics and Space Administration (NASA) in anticipation of the SGP '97 (Hydrology) campaign to be conducted in summer 1997 and by GEWEX/GCIP for long-term climate considerations. An Oklahoma Mesonet surface meteorological observation station (SMOS)-type installation already exists at El Reno, so an ARM SMOS is not necessary there.

In addition, three intermediate facilities (Table A.3 in Appendix A) have been installed and became operational during the last six-month period. These new sites are at Beaumont, Kansas, Medicine Lodge, Kansas, and Meeker, Oklahoma. All contain a 915-MHz profiler with RASS. The consensus data are collected automatically on a daily basis, but spectral data are downloaded manually by site operations every two weeks during their regular site visits. Finally, the four boundary facilities (Table A.4 in Appendix A) have completed infrastructure. Figure 1 is a map of the SGP site showing the locations of the developed extended, intermediate, and boundary facilities. The status of the systems and instruments anticipated by June 30, 1997, is summarized in Table 1.

In addition, ARM is developing a mission critical database that will make it possible to provide a common location for all information (other than instrument data streams) that enhances the scientific utility of the individual instrument data streams. For example, such information includes instrument calibration and maintenance records, Data Quality Reports (DQRs), Problem Identification Form (PIFs), Corrective Action Reports (CARs), etc. Considerable interaction will take place between the DSIT and site operations during this six-month period to integrate site operations databases with the ARM Program database.

3.2.2 Launch Schedule for Balloon-Borne Sounding Systems

Until the full suite of remote sensing systems is deployed to perform deep, detailed soundings of the wind, temperature, and moisture of the troposphere under a wide range of conditions, the BBSS will continue to be an expensive workhorse owing to the cost of the expendables and manpower associated with an ambitious schedule of radiosonde launches. The number of BBSS launches sitewide should eventually be reduced to a minimum needed to support routine cross-checks on the remotely sensed measurements, but we are a number of years from that goal. The frequency of routine launches at the central facility during this six-month period will be the same as in the previous six months. Routine operations (see Table 2) will include five daily launches at the central facility and one daily launch at each of the four boundary facilities.

The current routine radiosonde launch times at the central facility were chosen to facilitate IRF and IDP research, and the launch times at the boundary facilities were chosen to support the microwave radiometer (MWR) and the nearby NOAA 404-MHz profilers with their recent or imminent RASS deployment and to complement the wider network of National Weather Service (NWS) radiosonde launches. Remote sensing of virtual temperature profiles at all boundary facilities is provided by the nearby NOAA profilers, which are being outfitted with ARM-provided RASS units. The RASS units have already been installed at the Purcell, Oklahoma, and at the Haviland, Kansas, NOAA profilers. The Lamont, Oklahoma, NOAA profiler will not receive a RASS unit because it would be located too close to a residence, but the

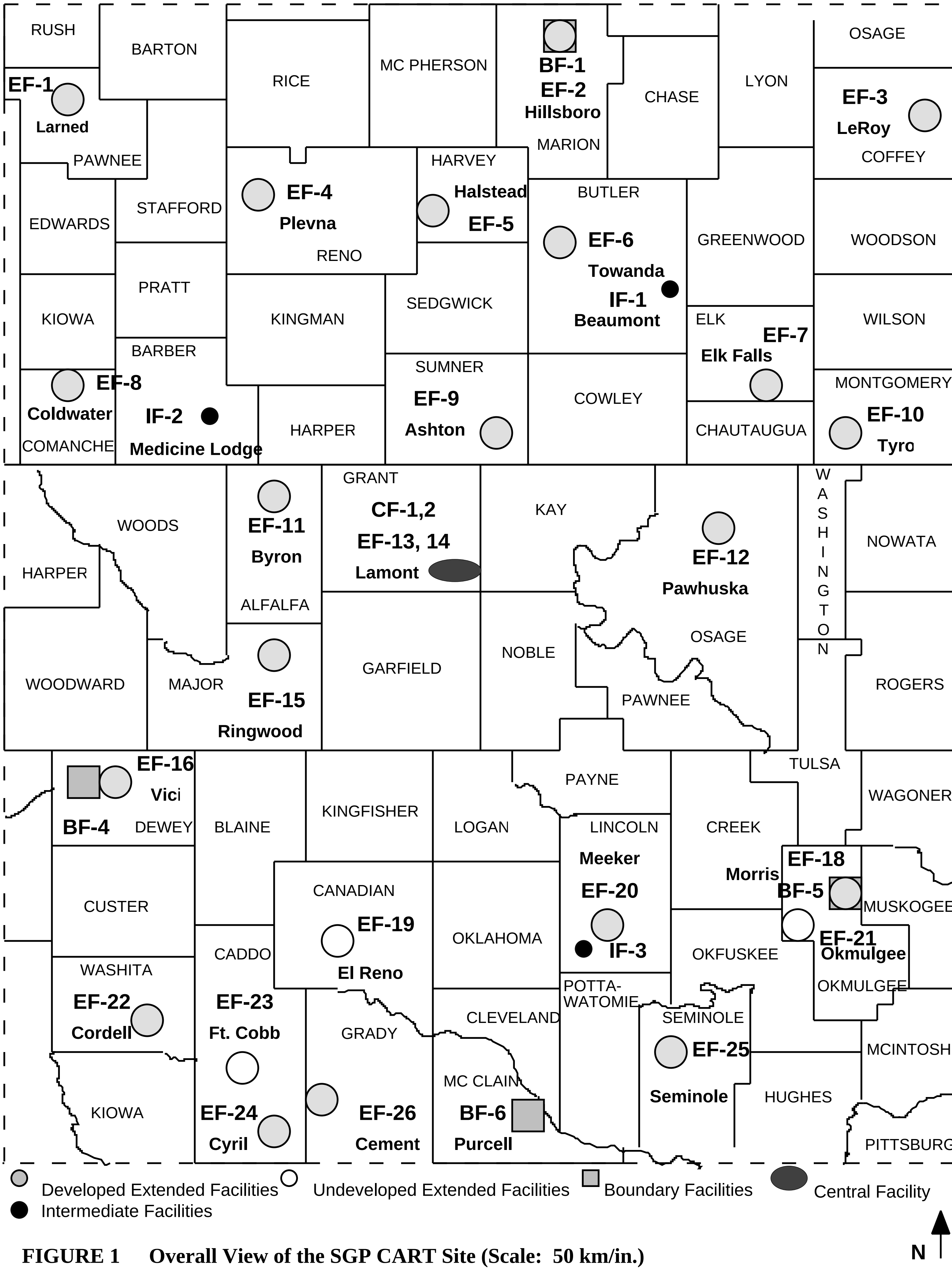

FIGURE 1 **Overall View of the SGP CART Site (Scale: 50 km/in.)**

TABLE 1 Instruments and Observational Systems in Place at the Central, Boundary, Extended, and Auxiliary Facilities on June 30, 1997[a]

Central Facility

Radiometric Observations

- AERI
- AERI X
- SORTI
- BRS
- BSRN
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
- SIRS (formally SIROS)
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - Pyranometer (upwelling, above pasture at 10 m)
  - Pyrgeometer (upwelling, above pasture at 10 m)
- MFRSR
- UV-B
- PAR
- MFR (upwelling, above pasture at 10 m)
- Pyranometer (upwelling, above wheat at 25 m on 60-m tower)
- Pyrgeometer (upwelling, above wheat at 25 m on 60-m tower)
- MFR (upwelling, above wheat at 25 m on 60-m tower)
- CSPHOT

Wind, Temperature, and Humidity Sounding Systems

- BBSS
- 915-MHz profiler with RASS
- 50-MHz profiler with RASS
- MWR
- Heimann IR thermometer
- Raman lidar

Cloud Observations

- WSI (daytime/nighttime)
- BLC (interim)
- MPL (IDP) ceilometer
- Millimeter cloud radar
- Vaisala ceilometer
- Sky video camera

Others

- Temperature and humidity probes at 25-m and 60-m levels on tower
- Heat, moisture, and momentum flux at 25-m and 60-m levels on tower
- EBBR
- ECOR
- SMOS
- AOS (samples at 10 m)
- RCF

TABLE 1 (Cont.)

Extended Facility Components

- SIROS
  - Pyranometer (ventilated)
  - Pyranometer (ventilated, shaded)
  - Pyrgeometer (ventilated, shaded)
  - NIP on tracker
  - MFRSR
  - Pyranometer (upwelling, at 10 m)
  - Pyrgeometer (upwelling, at 10 m)
- EBBR or ECOR
- SMOS
- SWATS

Auxiliary Facilities

None in preparation

Boundary Facilities

- BBSS
- MWR

Intermediate Facilities

915-MHz profiler and RASS

[a] AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; BRS, broadband radiometer station; BSRN, Baseline Surface Radiation Network; CSPHOT, Cimel sunphotometer; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IR, infrared; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MPL, micropulse lidar; MWR, microwave radiometer; NIP, normal-incidence pyrheliometer; PAR, photosynthetically active radiometer; RASS, radio acoustic sounding system; RCF, radiometer calibration facility; SIROS, solar and infrared radiation observing system; SIRS, solar and infrared station; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SWATS, soil water and temperature system; UV-B, ultraviolet B; WSI, whole-sky imager.

TABLE 2 Radiosonde Launch Schedule for January 1-June 30, 1997 (Times in UTC)[a]

Central Facility	Boundary Facilities
Routine Operations, January 1-April 13, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	
SCM IOP Operations, April 2-April 22, Monday-Sunday	
0300	0300
0600	0600
0900	0900
1200	1200
1500	1500
1800	1800
2100	2100
2400	2400
Routine Operations, May 5-June 30, Monday-Friday	
0600	
1200	
1500	1800
1800	
2100	

[a] IOP, intensive observation period; SCM, single-column model; UTC, universal time coordinated. Launch time is 30 min earlier; the stated time represents the approximate midpoint of the flight.

nearby SGP CART site central facility collects a relative abundance of thermodynamic data. The NOAA profilers located at Vici and Morris, Oklahoma, and Hillsboro, Kansas, are expected to have RASS installed during this six-month period. In addition, global positioning system (GPS) instruments were recently installed at the Purcell, Vici, Morris, and Hillsboro NOAA profiler locations to provide estimates of precipitable water. This information is expected to become available to the ARM Program during this period as external data, along with the NOAA profiler data.

The four boundary facilities routinely launch radiosondes once daily at 1800 universal time coordinated or noon local time. Boundary facilities will continue to be staffed only during the period of 1030-1430 local time, Monday through Friday (including holidays). During appropriate IOPs, the boundary facilities will be staffed 24 hours per day for 21 consecutive days (including holidays) to facilitate releases every 3 hours (Table 2).

The central facility will be staffed from 0430 to 1630 and from 2230 to 0230 local time, Monday through Friday (including holidays). During SCM IOPs, the central facility will be staffed 24 hours per day, 7 days per week (including holidays), to facilitate round-the-clock radiosonde releases every 3 hours. Hours vary for other IOPs or campaigns, depending on the operational requirements for the central facility.

3.3 Instruments

A CART instrument is any instrument that is approved by the ARM Program and for which the site operations management has accepted responsibility for operation and maintenance. The PRR and ORR forms are requests for information that facilitates the installation and operation of instruments or facilities at the SGP CART site. The purpose of these reviews is to achieve an efficient handoff of instruments and facilities from instrument mentors to site operators. Figure 2, the SGP CART instrumentation implementation flowchart, contains information obtained from the PRR and ORR documentation. When all procedures, operation manuals, and training pertaining to an instrument have been completed, the instrument is accepted by the site operations management. If sufficient documentation is available to operate an instrument, even though more will ultimately be required for full acceptance, the instrument may be operated in a degraded mode. The status of the instruments is summarized in Table A.5 in Appendix A.

Recent and ongoing instrument additions include the following:

- *Downward-Looking Infrared Thermometers, Completed*. Two more infrared thermometers (IRTs) at the central facility, one pointing downward on the 10-m mast in pasture and one pointing downward at the 25-m level above the wheat field, were installed and made fully operational in 1996.

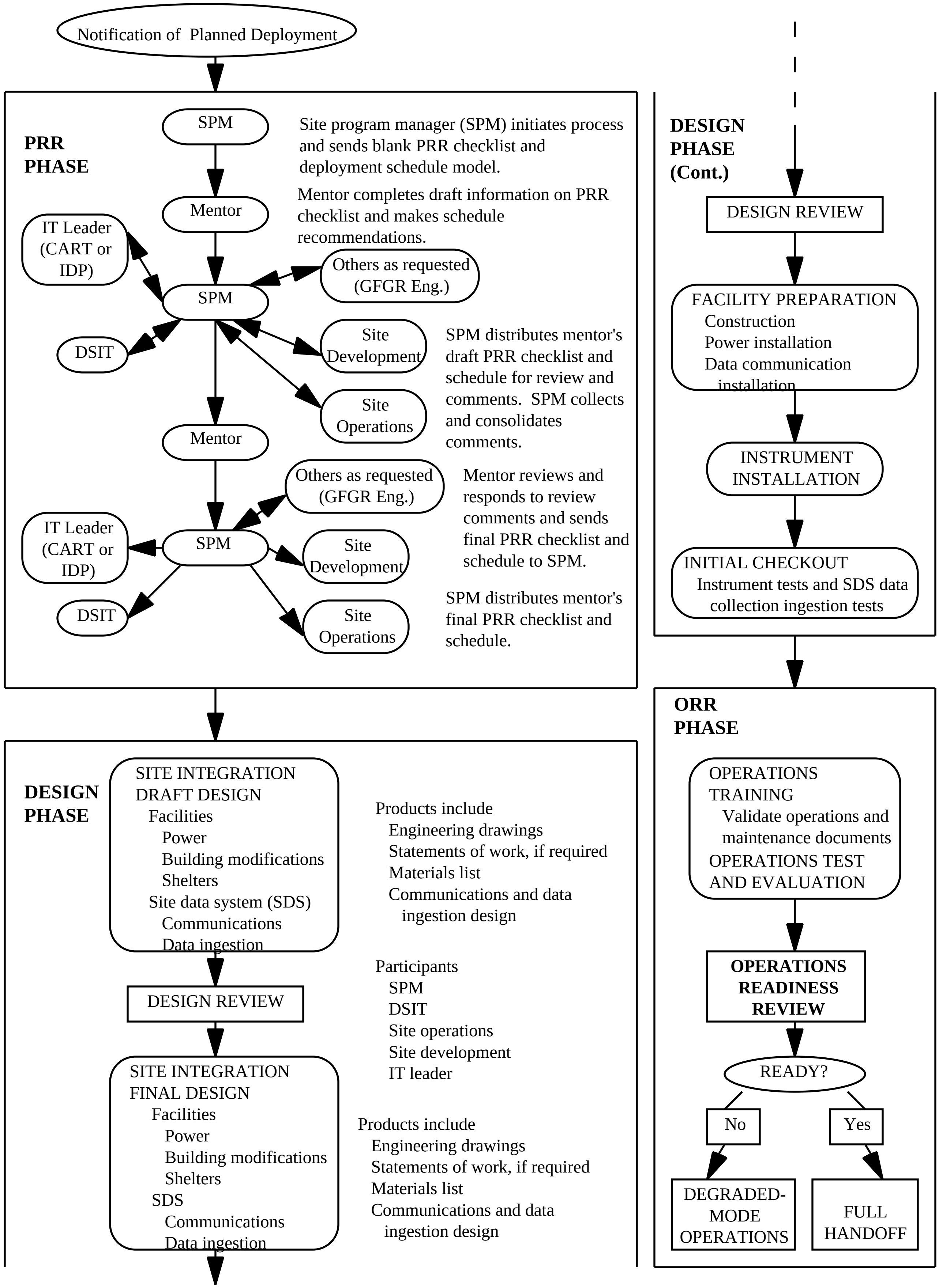

FIGURE 2 SGP CART Instrumentation Implementation Flowchart

- *Global Positioning Systems, Completed*. In a collaborative effort with NOAA, GPS receivers were deployed at five NOAA 404-MHz radar wind profiler (RWP) locations within the SGP CART site near the Hillsboro, Vici, Morris, and Purcell boundary facilities and near Lamont, Oklahoma, about 6 km (4 mi) north of the central facility. Analyses are carried out by NOAA, and the results are provided as external data to the ARM Program. The primary data product consists of estimates of precipitable water vapor.

- *Additional Level of Temperature and Humidity Observations on the 60-m Tower at the Central Facility, Completed*. An additional level of temperature and humidity observations was added at the 25-m level of the 60-m tower at the central facility. As a result of findings of the Water Vapor IOP in September 1996, improvements in selection, handling, and calibration of sensor elements probably will be recommended for both 25- and 60-m levels. Some have already been implemented.

- *Whole-Sky Imager, Installed*. A model EO-6 day-night WSI was installed at the central facility in late 1995 to replace the EO-5 daytime-only WSI that had been on loan from the Marine Physical Laboratory of the Scripps Institution of Oceanography. Data ingest is currently being implemented. A second day-night WSI will be considered for the SGP in 1997 at an auxiliary site yet to be established.

- *The 915-MHz RWPs and RASSs at the Intermediate Facilities, Installed*. The hardware for the instrument systems were installed and made operational during September 1996. Data-handling communication computers and data ingestion routines are now being implemented.

- *Millimeter Cloud Radar, in Progress*. Installation of a millimeter cloud radar (MMCR) was completed in December 1996 and is currently undergoing on-site tests. Development of ingest routines is a high priority, and considerable documentation has been developed and received by site operations for review.

- *Video Time-Lapse Sky Camera, in Progress*. Implementation of a video camera and reflector to obtain time-lapse video views of cloud conditions above the central facility is taking place. Current discussions center on the exact placement near the optical trailer and the housing for the system. This instrument is expected to be installed and operational this spring.

- *Cimel Sunphotometer at the Central Facility, in Progress*. Acquisition has been initiated of a CSPHOT for installation at the central facility. The CSPHOT will provide measurements of aerosol optical depth to supplement the multifilter shadowband radiometer (MFRSR) and to tie in with a global network of each sunphotometer supported in part by NASA. In addition to measuring optical depths, the system will be used to observe the sky radiance along the solar almucantar and along the solar principal plane, including the solar aureole. The resulting data can be used for research on inferring aerosol size distribution and the scattering phase function. This instrument is expected to be installed and operational this spring.

- *The UV-B and Photosynthetically Active Radiation Sensors, in Progress*. A set of sensors and a data logger have been acquired to measure the downwelling hemispheric solar radiation in the UV-B and photosynthetically active radiometer (PAR) bands at the central facility. Making these observations is an efficient means of increasing collaborations with other programs. Implementation has been delayed because of the potential need to include additional relatively simple sensors to this platform (e.g., a transmissometer).

- *Optical Transmissometer, in Progress*. A commercially available transmissometer will be acquired to detect fog, dust, and drizzle too light be recorded by rain gauges. Such phenomena are best detected by open-path devices rather than through a large sampling stack such that as being used with the aerosol observation system (AOS). The data will be useful for evaluation of signals from radars, lidars, and the MWR.

- *Establishment of Instruments at an Extended Facility at a Forested Site, in Progress*. A walk-up scaffolding tower for supporting an ECOR system, a SMOS, and a solar and infrared station (SIRS) above the forest canopy at the Okmulgee extended facility is being acquired. Installation during this spring is expected.

- *Soil Water and Temperature Systems for Measuring Vertical Profiles of Soil Water Content and Temperature (a Joint Venture between GCIP and ARM), Installed at Existing Extended Facilities*. Data ingest and delivery to the Experiment Center are expected during this spring.

- *Ceilometers and AERIs at Boundary Facilities, Planned*. Four Vaisala ceilometers have been acquired for installation at the boundary facilities in 1997. These ceilometers are capable of detecting cloud base to a height of about 7.5 km. These ceilometers are intended primarily to provide data for algorithms to retrieve temperature and humidity profiles in the lower troposphere from AERI data. Delivery and installation of the AERIs and ceilometers are expected this spring.

- *Solar Spectral Radiometer, Planned*. The need for solar spectral observations at the central facility has been repeatedly expressed for testing and improvement of solar radiation models. We are currently gathering information on the characteristics of devices that are available. A portable field spectroradiometer system for wavelength ranges of both 350-1,100 nm and 1,100-2,500 nm is available commercially, but some questions remain. Usually, solar spectrometers do not retain calibrations during shipment; establishment of a suitable calibration laboratory at the central facility has been contemplated but not carried out because of the rather high costs and the need to have adequately trained personnel travel to the site for the calibrations. Preliminary suggestions from a potential vendor indicate that the spectrometer might maintain calibration during a shipment back from a calibration laboratory, which would have to occur once or twice per year. Another aspect to be worked out is the configuration and number of spectrometers that would be required for measuring the spectral composition of the direct beam radiation, the diffuse irradiance, and possibly the fixed, zenith, narrow-field-of-view radiance. Finally, the extent of weatherization of available devices for long-term continuous operation is not sufficiently well known. Some of these questions imply requirements for measurements and mode of operation that might have to be reconsidered.

- *Radiation Calibration Facility, Sufficiently Completed and Operational for Radiometer Calibrations*. During the first six-month period of 1996, the construction of the radiometer calibration facility (RCF) was completed. Fully operational, the facility includes a calibration deck; a reference spectroradiometer (300-1,100 nm); a site reference cavity radiometer; a program reference cavity radiometer; a site working-standard cavity radiometer; automatic solar trackers for direct and diffuse solar measurements; reference diffuse pyranometers; working-standard pyranometers, pyrheliometers, and pyrgeometers; National Institute of Standards and Technology (NIST) standard lamps; blackbody circulators; and computer hardware and software support. The RCF will greatly aid the ARM Program in its ability to collect the best radiometric data possible. The first Broadband Outdoor Radiometer CALibration (BORCAL) was held successfully at the RCF in September 1996. Plans are being developed now for year-round use of the RCF and possible calibration exercises held remotely at the extended facilities.

The SGP CART site instrument performance, the availability of new commercial instruments, and additional data stream requirements result in a list of potential new instruments that is reviewed by ARM infrastructure staff. Recommendations are then made to the Science Team Executive Committee for approval. Planned and potential enhancements and new and additional instruments that have been suggested and are now under discussion within the ARM infrastructure staff include the following:

- *Improved Solar and Infrared Radiation Observing System Data Logging at Extended Facilities, in Progress*. New data loggers and associated data equipment have been acquired to provide an independent data logger for the non-MFRSR components of solar and infrared radiation observing systems (SIROSs) and for the central facility Baseline Surface Radiation Network (BSRN). The new platforms will be named SIRS and broadband radiometer station (BRS) for "solar and infrared station" and "broadband radiometer station," while the MFRSRs will have independent "MFRSR" platform names. A schedule for implementation calls for conversion to be completed by August 1997. The new SIRS platform is expected to have considerably greater reliability than that achieved with the MFRSR-logger-based platform, and the computations will allow data capture that meets international standards.

- *Occasional Tethersonde Measurements of Humidity Profiles at the Central Facility, Completed*. A tethersonde system with a high-quality humidity sensor repeatedly made measurements of temperature and relative humidity profiles in the lower 1 km of the atmosphere above the central facility during the Water Vapor IOP in September 1996. This system will probably be used in future SGP IOPs.

- *Upgrades of the Radiosonde System, in Progress*. Steps have been taken to upgrade the CART BBSSs to use GPS-based rather than loran-based tracking for determining position, which will be necessary during the next few years as loran-C transmitters are phased out. In addition, a new type of Vaisala radiosonde, which uses the RS-90 sonde instead of the RS-80 version presently used, is expected to become available within a year. The humidity sensor on the RS-90 sondes is reported to have a faster response and to recover more quickly after emerging from clouds. The temperature sensors are smaller and thus probably considerably faster in response and less susceptible to the effects of heating by solar radiation. The RS-90 sondes cost about the same as do RS-80 sondes; the conversion of receiving systems costs $2,000 to $3,000 each. A thorough evaluation of the RS-80 versus the RS-90 sondes would be beneficial for ongoing and subsequent studies of atmospheric radiation transfer. Although some comparisons can be made at the CART site with sequential flights of each type of sonde, a better means of evaluating both types of sondes would rely on flying both types attached to the same balloon. Plans were made to carry out such a comparison during the Water Vapor IOP in September 1996, but the vendor had found some flaws in the RS-90 sondes, which has delayed their availability. In addition, reference temperature, humidity, and pressure sensors were installed at the balloon launch site at the central facility to provide surface reference values. This installation is being evaluated before installing such sensors at each of the four boundary facility BBSS launch sites.

- *Ceilometer with a 21-km Range, Being Considered*. Vaisala manufactures a ceilometer with a 75,000-ft range that is undergoing evaluation at the central facility. Some improvements in software are being tested. If it were to meet expectations, this device would provide an alternative to the micropulse lidar (MPL) and would be considered for some locations because of the difficulty of obtaining replacement components for the MPL. The Vaisala ceilometer, however, has very limited capabilities for detecting the height of the planetary boundary layer via backscatter from aerosols and currently seems to be a candidate only for locations where aerosol backscatter is measured with other devices, such as the central facility, or where information on boundary layer height is not continuously needed.

- *Enhancement of the Vaisala Ceilometer, Being Considered.* The present Vaisala ceilometer system could be enhanced by addition of a stepping motor and motor control that would allow mechanized scanning of the ceilometer along one axis. Software would have to be developed and tested to use this function. The enhancement would allow the ceilometer to make three measurements that at present would require manual rotation of the ceilometer: (1) scan the sky, and analyze the return as a performance check on the cloud decision algorithm of the WSI; (2) periodic rotation of the ceilometer from the vertical to increase the optical path length in the boundary layer, thereby increasing the possibility of observing mixing depths from boundary layer aerosol returns; and (3) calibration of the ceilometer by rotating the system to a horizontal position and observing the return from a target a known distance away.

- *Extra High-Resolution AERI X, Being Considered.* A need was stated during early phases of CART planning to have at least two IR interferometers running routinely at the central facility. Two systems were said to be needed to improve evaluation of the uncertainties of the radiance observations. Because the AERI X has a resolution about 10 times greater than the AERI and would provide the best available emission observations for comparison with line-by-line calculations, it could be considered an enhancement or new observation, in addition to contributing to completion of the site instrumentation. The high-resolution system provides a more dependent check of radiance readings than would a second AERI of standard resolution because a different type of interferometer is used. A prototype AERI X has run successfully at the central facility on several occasions. Acquisition of an AERI X for routine operation at the central facility is currently being considered.

- *Zenith Sky Radiance in the Near Infrared, Being Considered*. An uplooking near-IR shortwave radiance instrument with a field of view overlapping or nearly coincident with the MWR and possibly the cloud radar has been suggested. The wavelengths detected should be in a fairly narrow band near 0.9 μm, and the field of view should coincide with the MWR field of view as much as possible. Such a device is needed to improve understanding of the relationships between liquid water path and shortwave radiation. At the central facility, the sensor could be mounted next to the UV-B and PAR radiometers and use the same data logger. Preliminary tests with the MFRSR sensing head mounted in a collimating tube had an adequate signal-to-noise ratio to be used for this purpose. A specially designed device for this purpose might be made by a private company at a modest cost. For the SGP site, however, it has been suggested that a narrow-field-of-view viewer used with a solar spectrometer that would also take global and direct-beam solar measurements might be more effective.

- *Addition of Rain Gauges at Six SWATS Locations Where No SMOS Exists, in Progress*. These rain gauges are needed in proximity to SWATS to learn more about the flux of water from the near-surface atmosphere through the layers of soil measured by SWATS for realistic soil water balance estimations. The data are necessary for determining soil moisture characteristics for distributed surface models and for building empirical relationships between soil water status and surface energy and water partitions. Studies have shown that antecedent precipitation is a dominant cause of spatial variation in surface exchanges across a wide area like the CART site, working its way through into a convective response in the atmosphere, perhaps influencing cloud formation.

Measurement issues currently unresolved by the ARM infrastructure include the following:

- *Continuous Direct-Beam Solar Irradiance Measurements with a Cavity Radiometer*. Documentation for the BSRN specifies that an all-weather windowless cavity radiometer be operated at the BSRN site. This task is not feasible at the SGP CART site central facility because of dust conditions. Operation of a windowed cavity radiometer, one of which has already been purchased for this purpose, might be possible at the RCF, but considerable effort would be necessary for continuous operation. Some compromise for part-time or discontinuous operation might have to be developed.

- *Absolute Solar Transmittance Interferometer and Solar Radiance Transmission Interferometer*. Support of absolute solar transmittance interferometer (ASTI) development and solar radiance tranmission interferometer (SORTI) implementation at the central facility has been suspended for the time being. Efforts are focusing on obtaining a commercially available solar spectrometer, which is addressed in a previous entry.

- *Local Observations of Surface Vegetative Conditions at Extended Facilities*. The interpretation of data on, and the modeling of, surface latent and sensible heat fluxes at extended facilities would be assisted with routine observation of leaf area index and surface optical reflectance properties represented by the nondimensional vegetative index. Local leaf area index measurements might be too variable to be of much use, but local measures of nondimensional vegetative index were believed to be particularly important for interpretation of nondimensional vegetative index values derived from remote sensing data from satellites. The satellite could then be used to help infer the values and variability of surface heat fluxes for the overall SGP CART site. Relatively simple devices that obtain a measure of nondimensional vegetative index can be obtained at a modest cost and are currently being investigated.

- *Additional Extended Facilities at the SGP CART Site*. Some concern has been expressed recently that the spatial coverage of extended facilities for measuring air-surface exchange rates of heat and moisture seems to be incomplete, particularly to the south and southeast of the central facility. A review of the current site distribution needs to be carried out.

- *Surface Bidirectional Reflectance*. Measurements of surface bidirectional reflectance have been suggested at times for the SGP CART site, and a commercial source of the portable apparatus for rapid acquisition of bidirectional observations of the land and the atmosphere (PARABOLA) is available. Such an observation would be quite useful in the interpretation of solar reflectances seen from satellites. A commercial system is available but is not suitable for routine observations. Currently, a new Science Team project is addressing this observational need.

- *Profiling with Passive Microwave Systems*. A passive microwave radiometer for obtaining profiles of temperature through clouds could augment or supplant profile measurements made with the AERI at the boundary facilities. The primary advantage of microwave profiling is that it penetrates through clouds, which is not accomplished with any of the water vapor remote sensing systems currently in operation at the SGP CART site. Radiometrics has been developing such a radiometer. Vertical resolution appears to be about 100 m near the surface and increases gradually to over 2 km at a height of about 10 km near its maximum range. A less expensive Russian system with slightly greater vertical resolution and a maximum range of about 600 m is currently being evaluated. If funding were provided, a passive system for water vapor profiling might also be successfully developed.

3.4 Observations, Measurements, and External Data

The observations being delivered to the Experiment Center from the SGP CART site as of December 31, 1996, are summarized in Table B.1 in Appendix B. The availability of data from a particular platform on any given day is a function of quality control, with some segments temporarily unavailable during evaluation or correction of problems. Instruments operating at the site that are not in Table B.1 either are still under evaluation by the instrument mentors or are awaiting the creation of the data ingestion modules required to add their data to the SGP data stream.

The measurements being produced at the Experiment Center as of December 31, 1996, for distribution to the Science Team are listed in Table B.2 in Appendix B. This summary includes both the measurements derived from the SGP CART data and data streams from sources external to ARM (e.g., the gridded data from the National Centers for Environmental Prediction model [ETA]). Table B.3 in Appendix B lists the external data that currently supplement the SGP CART data.

3.5 Site Development Activities

3.5.1 Facilities

In anticipation of the arrival of two day-night WSIs, the first of potentially six planned auxiliary facilities will need to be located. Auxiliary facilities are to be 5-10 km distant from the central facility and at approximately the same elevation as the central facility. At least one auxiliary facility is expected to be located and leased during this period.

The remaining extended facility site, Ft. Cobb, is to be an ECOR site. Discussions with Ft. Cobb officials have taken place off and on for nearly two years with little progress. Also, Ft. Cobb is close to Cyril (EF-24) and Cement (EF-26), allowing consideration for moving to a different agricultural location that might provide for better area representation of the SGP CART site. Other candidate areas are being explored. The Ft. Cobb site location is not expected to be resolved during this six-month period.

3.5.2 Development of the Site Data System

Several of the installed instruments and all new instruments will require creation of software to transfer the data from the instrument platforms to the SDS. Usually, transfer of data is accomplished by coded switches at the extended facilities and intermediate facilities or by T-1 lines at the boundary facilities. Most of the ARM SGP instruments have their data collected (or delivered) to the SDS regularly, with data processed (i.e., ingested) and passed on to the Experiment Center and the ARM Archive. Some exceptions to this pattern will continue to occur during the next six months. These exceptions are as follows:

- *SORTI*. The SORTI data are retrieved directly by the instrument mentor and do not enter the SDS computers.

- *WSI*. The WSI is connected to the network, but the data are retrieved at the Scripps Institution of Oceanography for processing and do not enter the SDS computers.

- *AERI 01*. The AERI 01 data are retrieved by the Experiment Center, and ingestion of the data occurs there. The data do not enter the SDS computers.

- *MPL*. The MPL data are received by the SDS computers but are not processed (because no ingestion module has been developed), except that the raw data files are renamed to the ARM file-naming standard.

- *Belfort Laser Ceilometer (BLC)*. The BLC data are collected by the SDS computers, but the processing (ingesting) of the data currently takes place at the Experiment Center. The data do not enter the SDS computers.

- *ECOR*. The 3-m ECOR systems recently installed at the central facility and extended facilities currently write data files to a Bernoulli disk unit that stores data for 17.9 days. Data processing by the SDS will commence before June 1997. Data are retrieved every two weeks from extended facilities.

- *Raman Lidar*. Data are expected to be retrieved from the Raman lidar in an automated fashion by the instrument mentor until ingestion can be completed. The data do not enter the SDS computers.

- *SWATS*. The SWATS data will be retrieved automatically by the instrument mentor until the ingestion module is in place. The data do not enter the SDS computers.

- *AOS*. The AOS data are being retrieved automatically every hour but are not ingested. The data do not enter the SDS computers.

- *RCF*. How data will be retrieved from the RCF is not clear at this time.

- *Intermediate Facility 915-MHz Profilers and RASS*. The spectral data from the 915-MHz profilers and RASS will be retrieved manually every two weeks. The consensus data will be retrieved automatically each day via the SDS.

- *MMCR*. How data will be retrieved from the MMCR is not yet clear at this time.

- *CSPHOT*. Data will be transmitted via satellite and downlinked by the mentor. The data will be collected by ARM as external data. The data do not enter the SDS computers.

- *Vaisala Ceilometer.* How data will be retrieved from the Vaisala ceilometer is not clear at this time.

- *Sky Video Camera for Clouds.* How data will be archived is not clear at this time.

Further work is being undertaken to facilitate routine operations and particularly to assess instrument performance, including a broader suite of data display capabilities. Once the SDS is near completion, procedures for system management and maintenance need to be written and transferred to site operations staff. In 1996, site operations management hired a site computer systems administrator, who will facilitate local SDS development, operation, and maintenance. In addition, the SDS continues to address the ongoing need to make near-real-time data available for selected scientists during IOPs and campaigns and for educational outreach efforts in conjunction with the Oklahoma Climatological Survey's EARTHSTORM project. A successful prototype system for delivering near-real-time data to scientists was used during the Water Vapor IOP of September 1996. This system will be formalized for use in future IOPs.

3.6 Limiting Factors

The most basic of limiting factors is the amount of resources available to continue site development, expand operations, and provide necessary support for the IT and DSIT. Shortfalls result in delays in implementation. Shortfalls in vendor supplies, delays in obtaining information for PRRs, and budgeting problems have also been hindrances. Other significant limiting factors are the time lags inherent in the procurement process and the calibration of radiometers before installation, though the latter should be relieved by the presence of the new calibration facility.

All systems awaiting construction or installation go through a formal design review of structural and mechanical systems. These reviews frequently identify deficiencies in plans and drawings related to engineering requirements, procurement details, safety, and quality control. This review activity was expanded to include large or complex IOPs (e.g., the ARESE IOP in September 1995) in an effort to integrate the exceptionally wide variety of IDP instrument support requirements for cost-effective and safe implementation. Neither construction nor installation can begin until the design review process has been successfully completed.

The costs associated with BBSS launches (primarily expendables) will continue to be a burden on the operations budget until these systems are replaced by continuous, unmanned remote sensing systems, if ever. These expenses are a strong constraint on the total number and frequency of launches, making impossible the routine provision of all of the requested launches (eight per day at the central and boundary facilities), defined as the optimal sounding strategy for SCM requirements by the DSIT (M. Bradley and R. Cederwall, unpublished information).

4 DATA QUALITY

Data quality issues are addressed at several levels within the ARM Program and at the SGP CART site. One of the goals of the ARM Program is to provide data streams of known and reasonable quality. Maintaining data quality for a program of this size and complexity is a significant challenge. Data quality assurance within the ARM Program infrastructure has matured over the past few years and will continue to evolve, with the SST continuing to develop the stronger role that it assumed during the previous six-month period.

4.1 Instrument Mentors

Instrument mentors are charged with developing the technical specifications for instruments procured for the ARM Program. The instrument mentor then tests and operates the instrument system (either at his or her location or at the SGP CART site). In addition, the mentor works with SDS personnel on ingestion software requirements. Data ingestion involves the conversion of data streams to the International System of Units (SI), as well as the acquisition of parameters that can be used to monitor instrument performance (e.g., monitoring an instrument's output voltage for a 5-V power supply or the continuity of the wire in a hot-wire anemometer). Data collection and ingestion, then, are the focus of the first level of data quality assurance. Quality at this level is monitored routinely by site operators and instrument mentors.

The next level of data quality assurance involves beta release of data streams from individual instruments. The mentor receives the data from the instrument to determine whether the technical specifications of the instrument are being met. When the mentor is satisfied that the instrument is functioning properly and that the technical specifications have been met, the data are formally released to the Science Team and other data users. The instrument mentor is also charged with reviewing the instrument data streams at least once every two weeks, an action monitored at the Experiment Center.

Instrument mentors also provide all operations and maintenance documents and lists of spare parts to site operations. Typically, the mentor provides additional detailed documentation and hands-on training so that appropriate support can be provided by site operators. This activity is part of the ORR process.

4.2 Site Scientist Team

The SST helps to ensure that the scientific productivity of the SGP CART site is maximized by both the routine and special (IOP) operations at the site. The SST acts a resource for the site operations manager and his staff on scientific matters related to instrument data streams by doing the following:

- Fielding and answering questions from site operations personnel concerning potential instrument problems

- Reviewing proposed instrument siting and deployment strategies, including the needs of the instrument mentors and instrument requirements for IOPs and campaigns

- Reviewing schedules and procedures for instrument calibration and maintenance

- Providing an initial confirmation of suspected instrument or data problems through the use of performance metrics, graphic display techniques, and data quality research investigations

These activities require constant communication with site operations staff, including routine visits to the central facility and occasional trips to extended, intermediate, and boundary facilities. These activities are also highly coordinated with the site program manager. Ongoing focus activities of the SST will contribute to the goals of data quality assurance for the SGP CART site and ensure that the operation of the site meets, as nearly as possible, the overall scientific goals of the ARM Program.

Recently, the SST placed an announcement to hire an on-site representative to perform first-line-of-defense quality data assurance, develop tools to perform data quality assurance, perform data quality investigation research on problems that require special attention, interact closely with the on-site operations manager and his staff at the central facility on all science-related activities, help in the planning and operation of IOPs, and help conduct on-site outreach activities. This newest member of the SST is anticipated to be on-site by spring.

In the past, data quality assurance efforts of the SST largely involved evaluation of individual and multiple sets of data streams as needed, on an exploratory or developmental basis (data quality investigations); participation in QMEs; and participation in the creation and workings of the VAPs Working Group.

Now that operational activities have shifted from deployment to support of ongoing, continuous operation of a wide variety of instrumentation at many locations, a more comprehensive, systematic data quality assurance effort is being initiated by the SST. This effort is manifested in several ways, including the evaluation of the calibration and maintenance information, the development and use of automated, graphic display techniques for use by site operators in daily monitoring of data quality (beginning in October 1995), and (beginning in early 1996) the development of performance metrics that systematically determine what percentage of the collected data falls within given quality tolerances. Graphic display techniques for monitoring data quality have been developed for SIROS, MFRSR channels 1-6, sitewide albedo, IR radiation, and comparisons of BSRN and SIROS data. Although a Web site was initially dedicated for the program-wide viewing of these display modules, at this time they are being ported to program scripts that can be run daily by site operators to aid in their first-line-of-defense quality control activities.

The development of performance metrics began in February 1996 and to date has concentrated on the MWR, BBSS, EBBR, SIROS, 915-MHz RWP, EBBR/SIROS net radiation comparisons, SIROS/BSRN comparisons, and, recently, EBBR and SMOS surface objective analysis. This effort is aimed at systematically determining the data "health" of the site via time series (numerical and graphic) of the metrics. The ultimate format of this presentation is under development. In late 1996, the SST began issuing SIROS data with the goal of attaining quicker resolution of instrument and data quality problems. Plans for this six-month period and beyond include development of graphic display technique scripts for more data streams, the development of explicit guidance materials to allow site operations staff to use the display techniques effectively, continued development of performance metrics, and continued evaluating of the calibration and maintenance information, with an eye on developing presentation formats for use by different groups such as site operations and actual data users. Thus, with the assistance of the site operations staff, the SST will be able to serve the ARM Program goals better by laying a foundation for improving data credibility.

Finally, a new ARM-wide initiative aimed at ensuring the quality of shortwave radiation data began during the latter half of 1996. The backbone of this tracking system will be performance metrics developed by the Site Scientist and SIROS instrument mentor and produced and packaged in near real-time by the DSIT. Components of this tracking system cover 10 measurement components: downward hemispheric flux, direct broadband component, diffuse broadband component, direct spectral component, diffuse spectral component, optical depth, net shortwave surface radiation, broadband albedo, spectral albedo, and calculated quantities (zenith angle, effective top of atmosphere horizontal flux). Performance metrics for some of these components already exist; others do not. We hope to have an analysis product up and running by August 1997.

4.3 Quality Measurement Experiments

As part of the data quality assurance effort, the focus goes far beyond the calibration of instruments and analysis of individual data streams to intercomparisons of data streams and evaluations of our ability to capture an accurate representation of the state of the atmosphere (through QMEs). The QMEs are investigations designed to evaluate and enhance ARM data quality. They are suggested by the instrument mentors, the DSIT, and the SST. These efforts are expected to lead to peer-reviewed publications, a result strongly encouraged by the ARM Program. Such publications would allow data quality to be documented in the open literature. Specific QMEs are listed in Section 5.4.

For a large data collection program, procedures must be in place to facilitate the documentation of problems and their associated resolutions. The ARM Program is tasked with creating data of "known and reasonable" quality. To achieve this quality, the Problem Review Board (PRB), a small multilaboratory team with broad-based membership, facilitates the resolution of problems identified by "anyone" along the data pipeline. The PIF and CAR are forms that allow a formal mechanism for capturing information about potential problems, the potential impact on the quality of the data, and the correction action needed to resolve the problem.

The goal of the PIF/CAR system is to provide "end-to-end" problem management. No single person has the expertise to correctly resolve all classes of problems that might be identified in the ARM Program. The PRB technically reviews all incoming PIFs for their immediate impact on data connection and quality and assigns responsibilities for their correction and response (i.e., CAR).

The PRB is a small multilaboratory team with a broad base of membership. It is composed of a chairman, an oversight individual, and a representative from each of three teams: the IT, the Site Operation Team, and the DSIT. The PRB will oversee the assignment of problem-solving actions as triggered by PIFs and the resolution of the problems as documented in CARs.

A PIF should document anything that impacts the data of the data system or anything that more than one person needs to know or learn from. Not every PIF will identify a real problem. In some cases, the PIF will identify a misunderstanding or someone's need for more information. Some problems will have an obvious solution, but the timing of the corrective action may need to be coordinated with other subsystems within the project. Some problems will require further analysis to be understood, and some problems may require just documentation because no clear solution can be identified at the time. A review of the PIF is required before the PIF is accepted as a problem and before it is actually scheduled for resolution. The CAR documents the details of the resolving action. The corrective action required is an end-to-end problem solution, not just a fix in a software module.

In addition, a DQR may be required. A DQR is a statement about the quality of data from a particular instrument. Usually, a DQR is generated by an instrument mentor. If not generated by the mentor, it must be reviewed by the mentor. The DQR information could be quite simple (e.g., stating that a instrument system was turned off during certain time periods because of unexpected hardware problems), but it could also be quite complex, giving detailed analysis and equations that should be used to adjust the instrument observational data. One advantage of the DQR in comparison with a PIF is that the DQR form is simpler. It is easier to fill out and less cumbersome to incorporate into a data stream. If a large amount of processing of data is implied or requested in the DQR, reprocessing could be delayed for a long time. Hence, the description of the problem and the fix must be complete, so that someone could accurately reprocess the data several months after the date of the DQR submission. Equations, listings of numbers, etc., may be necessary and are acceptable if they are clearly explained.

The PIFs should continue to be used to request action by others, or oneself, to find a solution to a problem or generate information on it. A borderline case might be to state that data should be flagged during data ingest as a result of quality control algorithms provided as part of the form submitted. In this case, a PIF rather than a DQR is favored because a specific type of implementation is being requested. On the other hand, application of data quality control algorithms to data already collected and resident in the Experiment Center or the Archive would be best handled with a DQR. DQRs tend to be retrospective.

In case of doubt on whether to use a PIF or a DQR, using a PIF is better because it will automatically be examined by the PRB to see if the PIF should be converted to a DQR. If data flagging of an algorithm needs to be implemented both retrospectively and on the current data ingest, consider splitting the request into two parts: a PIF and a DQR.

The PIF/CAR/DQR database can be found at

http://www.arm3.das.bnl.gov/sisg/pifear.html .

5 SCIENTIFIC INVESTIGATIONS AND OPPORTUNITIES

In 1994, the ARM Program identified a need for the creation of a SAC to provide assistance to the ARM Program Science Team, the SGP CART site scientist, and the SGP CART site program manager. The SAC's charter is to

- Evaluate the SGP CART site scientific mission,
- Provide scientific mission guidance for SGP CART site operations,
- Evaluate the research program of the site scientist,
- Evaluate the potential for collaboration with other research programs, and
- Provide recommendations for the SGP CART site educational outreach program.

The seven-member SAC is composed of ARM and non-ARM Program scientists who meet formally at least once per year. The first such meeting was held in November 1995 at the University of Oklahoma (OU), and a second follow-up meeting was held in June 1996. A written report summarizing the SAC's recommendations on the basis of the first meeting was distributed in early 1996 to the ARM Management Team, the SST, the site operations manager, and the site program manager and was responded to in writing by the SST. The report from the June meeting should be finalized early during this six-month period. Individual committee memberships last for three years.

5.1 Intensive Observation Periods

The foundation of the ARM Program at the SGP CART site is the suite of continuous, routine observations, but some critical observations either can be too expensive to be made continuously or require instrumentation that cannot be deployed continuously. In addition, some questions concerning data accuracy or representativeness (for either established instruments or prototypes) can be answered only during periods of more intense observations. Acquiring these observations requires special efforts and arrangements by the SGP site staff. Such efforts are categorized as IOPs because they include activities beyond the routine observations and operations. The IOPs can be held in support of the needs of the Science Team, QMEs, IDP, campaigns, and even field tests of non-ARM instruments. Table 3 lists IOPs that have occurred, are in progress, or are in the design stage.

The SCM IOPs form the foundation for the IOP program because these IOPs involve three hourly simultaneous radiosonde launches at five locations that provide extensive characterization of the state of the atmosphere over the SGP CART site domain. The scheduling of other IOPs during SCM IOPs has a significant benefit in keeping costs manageable. The SGP site has shown that it can support scientific investigations on relatively short notice (e.g., Water Vapor IOPs), but budgetary impacts must be considered. The scientific prioritization of IOPs and their effects on routine operations are evaluated continuously.

The IOPs and campaigns are, in general, proposed to the DSIT by Science Team members, ARM infrastructure staff, the SST, the SAC, and other agencies. The DSIT integrates and develops specific requirements into a document that is passed on to the site program manager for evaluation, assessment, and budgetary consideration. Data from guest instruments collecting data during IOPs can be located and acquired by contacting the DSIT.

The IOPs of key scientific interest during this upcoming six-month period are discussed in the following paragraphs.

The Spectral Imagery Technology Applications Center IOP. The purpose of this IOP is to acquire data to obtain ground truth measurements and to improve atmospheric compensation models. The primary goal is to analyze approaches to atmospheric compensation on hyperspectral and ultraspectral image data obtained from satellite platforms. Two independent five-day activities have been scheduled. The first took place December 6-10, 1996, and the second five-day activity is scheduled to take place in March 1997. The Spectral Imagery Technology Applications Center (SITAC) IOP involves an aircraft and support provided by SITAC participants. The DSIT representative for this IOP is Don Slater, Pacific Northwest National Laboratory (PNNL), who can be reached at (509) 372-6049.

The Spring 1997 Single-Column Model IOP. An SCM is a physical parameterization package extracted from a GCM or other large-scale model. The SCM is a primary test of our current understanding of clouds and radiative transfer. The SCM IOPs are designed to provide, as boundary conditions, the advective tendencies and vertical velocities that are the dynamic forcing normally calculated with a GCM. The BBSS is the only technology currently capable

TABLE 3 Intensive Observation Periods

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
11/92	Field Test of NCAR Flux Profiler	D. Parsons (NCAR)	R. Cederwall	Enhanced soundings at the central facility and profiler site were made 11/10-11/19; boundary layer flights were also conducted on a few days.	Completed; data available
4/93	AERI Field Test	H. Revercomb (UW)	J. Liljegren	Enhanced soundings at the central facility were requested during the field acceptance test of the AERI instrument.	Completed 4/29/93
5/93-6/93	Using the GPS for the Measurement of Atmospheric Water Vapor	Collaborative (UNAVCO and NCSU)	J. Liljegren	The purpose was to test the investigators' technique for inferring total precipitable water vapor in the atmosphere column by using GPS signals.	Completed 6/8/93; data available
6/93	Warm-Season Data Assimilation and ISS Test	D. Parsons (NCAR)	R. Cederwall	This test was an enhanced sampling (in time and space) of the SGP domain for a 10-d period with profilers and sondes. The primary goals of the IOP were (1) to study the performance of FDDA under thermodynamic conditions typical of the continental warm season and (2) to evaluate the estimates of divergence and vorticity from the prototype NCAR ISS with interferometric techniques, the triangle of three 915-MHz profilers, and the results of FDDA.	Completed; all data available at the Experiment Center except for FDDA, which is available upon request at NCAR
1/94; 4/94; 7/94; 10/94; 4/95; 7/95; 9/95; 4/96; 7/96; 4/97; 6/97; 9/97	Seasonal SCM IOP	D. Randall (CSU)	R. Cederwall	Seasonal IOP with enhanced frequency of observations, particularly vertical soundings of temperature, water vapor, and winds at central facility and boundary facilities for periods of 21 d; the required sounding frequency is 8/d. The data are required for quantifying boundary forcing and column response.	IOP being planned for 4/97

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
4/94; 9/95-10/95; 9/96; 9/97-10/97	ARM UAV	B. Ellingson (UoM)	D. Rodriguez	Measurements of clear-sky flux profiles acquired by a UAV and surface support data are to be used to understand clear-sky heating rates and the ability of models to reproduce the observations.	First IOP conducted successfully in 4/94; flight for ARESE IOP in 9/95-10/95; first 24-h UAV flight in 10/96
4/94-5/94; 4/95-5/95	Remote Cloud Sensing Field Evaluation	R. McIntosh (UM); B. Kropfli (NOAA); T. Ackerman (PSU); K. Sassen (UU); A. Heymsfield (NCAR); J. Goldsmith (SNL); and others	C. Flynn	The primary purpose was the field evaluation and calibration of several remote sensing cloud-observing instruments (some from the IDP project). *In situ* cloud observations were critical to the success of this IOP. Enhanced soundings were required at the central facility.	Completed; data analysis in progress
5/94	WB-57 Overflight for the Measurement of Atmospheric Water Vapor at High Altitude	Collaborative (Visidyne and Lockheed PARC)	J. Liljegren	The purpose was to attempt to infer the vertical distribution of water vapor at high altitudes from solar transmission spectra.	Completed; preliminary transmission spectra delivered to ARM
5/94	VORTEX IOP	E. Rasmussen (NSSL)	D. Slater	Special launches were made in support of VORTEX, testing hypotheses on the development and dissipation of severe storms.	Completed 5/31/94
8/94	GEWEX/GCIP/GIST IOP	Collaborative	T. Cress	Special launches were made in support of the GCIP and GIST as part of an effort to improve climate models by improving parameterizations of hydrologic and energy cycles.	Successfully conducted in 8/94

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
9/94-10/94; 6/95-7/95	Sampling of Coherent Structures with the 915-MHz Profiler	R. Coulter (ANL)	R. Cederwall	Fluctuations in the vertical wind and index of refraction were observed by operating the 915-MHz profiler with RASS in a special mode during the afternoon hours to sample convective plume structures.	Completed
4/95-5/95	Simultaneous Ground-Based, Airborne, and Satellite-Borne Microwave Radiometric and *In Situ* Observations of Cloud Optical Properties and Surface Emissivities	W. Wiscombe (NASA-GSFC); E. Westwater (NOAA-ETL)	D. Slater	Observations of cloud optical properties were obtained over the CART site simultaneously from ground-based, *in situ*, and satellite-borne sensors; spatial variability of surface emissivities was assessed to attempt retrieval of total precipitable water and cloud liquid water from the special sensor microwave imager.	Completed; involved collaboration between Wiscombe and L. Fedor at NOAA
4/95-5/95	VORTEX-ARM	E. Westwater (NOAA-WPL); W. Wiscombe (NASA-GSFC); G. Stephens and P. Gabriel (CSU); J. Schneider (CIMMS/ NSSL)	D. Slater	A joint VORTEX-ARM proposal was approved for 45 h of P-3 aircraft time to study stratocumulus clouds. Work was coordinated with Remote Cloud Sensing IOP.	Data exchange completed 12/95
6/95-7/95	Surface Energy Exchange IOP	C. Doran (PNNL); R. Coulter (ANL); R. Stull (UBC)	R. Cederwall	Detailed observations of the temperature and moisture profiles in the PBL obtained within a radius of 75-125 km of the central facility by using airsondes and profilers to evaluate the variations of the PBL structure in relation to underlying surface fluxes.	Completed; airsonde data available as beta release from C. Doran

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
9/95-10/95	ARESE	Collaborative	T. Cress	The purpose was to study the anomalous absorption of solar radiation by clouds. The phenomenon was first noticed when satellite measurements of solar radiation absorbed by the surface atmosphere were compared with solar radiation measured at collocated surface sites.	Completed; data are available
4/96-5/96	SUCCESS	Collaborative	R. Peppler	The purpose is to determine the impact of the current and the future subsonic aircraft fleet on Earth's radiation budget and climate.	Completed
6/96	MSX Satellite Overflights	Collaborative	H. Foote	The purpose is to provide ground truth support for the MSX satellite. Nine MSX sensors operate in the range of 0.12-0.9 µm. A spectral IR imaging telescope also operates.	Launched on 4/24/96; SGP CART site flyovers on 6/17, 7/15, 8/12, and 9/9, and TWP CART site flyover on 10/13/96; data exchange in process
6/96-7/96	CLEX IOP	G. Stephens (CSU/CIRA); J. Davis (CSU/CIRA)	R. Cederwall	Intensified satellite data collection (by CSU), airborne cloud radar and *in situ* microphysical observations, and an array of ground-based measurements will be carried out for better understanding of the nature and role of middle-level, nonprecipitating cloud systems.	Completed; data exchange in process
7/96-8/96	BLX IOP	R. Stull (UBC)	R.Cederwall	Remote sensing surface fluxes with instrumentation on the University of Wyoming King Air; CASES site and NCAR mobile profiler involved; in conjunction with 7/96-8/96 SCM IOP.	Completed; aircraft data to be available in 1997; BAMS article submitted

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
7/96-8/96	LLJ IOP	D. Whiteman (PNNL)	R. Cederwall	The purpose is to investigate oscillations in the characteristics of the LLJ over the SGP.	Completed; data from 915-MHz profiler run in modified mode will be ingested in 1997 (available now from R. Coulter at ANL); Wyoming King Air data, in collaboration with R. Clark (MSU), will be available in 1997
9/96; 9/97	Water Vapor IOP	H. Revercomb (UW)	R. Peppler/ M. Splitt/D. Turner	First of a series of IOPs to take measurements of water vapor profiles using many instrument systems to attempt to define water vapor profile of the site in support of IRF research efforts. First in series focused on lowest kilometer; second in series to focus on upper altitudes (4-12 km).	Completed; data to be available in 4/97
12/96; 5/97	LMS/SITAC IOP	B. Dillman (Lockheed)	D. Slater	To analyze approaches to atmospheric compensation on hyperspectral and ultraspectral image data obtained from satellite platforms.	Waiting for good weather

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
4/97	Cloud Radar IOP	B. Martner (ETL); P. Daum (BNL)	D. Rodriguez/ M.-D. Cheng	Designed to validate retrieval of cloud microphysics on the basis of newly installed ARM zenith-pointing MMCR (developed by NOAA/ETL); ETL to operate collocated scanning NOAA/K-band cloud radar; high-altitude and low-altitude sampling to be done by two aircraft; aerosol components to be flown in clear-sky conditions by low-altitude aircraft.	Planning underway
Sum-mer 1997	SGP '97 (Hydrology) IOP	T. Jackson (USDA); M.-Y. Wei (NASA)	R. Cederwall	Conducted as part of USDA and NASA campaign to study 3 "recharge" events; additional ARM instruments will be installed at USDA El Reno extended facility; non-ARM aircraft with microwave radiometry will be sensing soil moisture.	Planning underway; joint agency meeting 8/96; site visit 1/97
9/97-10/97	Cloud/Aerosol IOP	G. Mace (PSU); S. Schwartz (BNL)	D. Rodriguez/ M.-D. Cheng/ P. Daum (aircraft coordinator)	Obtain on-site measurements of cloud and aerosol properties in cloudy and clear-sky conditions; single microphysics aircraft to be flown in conjunction with ARM UAV high/low set of airborne platforms measuring radiometric properties; unprecedented opportunity to quantify cloud/aerosol/radiation interactions.	Planning underway; in conjunction with UAV IOP

TABLE 3 (Cont.)

Date	Name	Science Team Member[a]	DSIT Contact[b]	Description	Status
10/97	CO_2 DIAL IOP	J. Jolin (LANL)	D. Slater	CO_2 DIAL on aircraft will overfly the site; has potential benefit for water vapor and aerosols measurements.	Site visit complete; planning underway

[a] Affiliations: ANL, Argonne National Laboratory; BNL, Brookhaven National Laboratory; CIMMS, Cooperative Institute for Mesoscale Meteorological Studies; CIRA, Cooperative Institute for Research in the Atmosphere; CSU, Colorado State University; ETL, Environmental Technology Laboratory; GSFC, Goddard Space Flight Center; LANL, Los Alamos National Laboratory; MSU, Millersville State University; NASA, National Aeronautics and Space Administration; NCAR, National Center for Atmospheric Research; NCSU, North Carolina State University; NOAA, National Oceanic and Atmospheric Administration; NSSL, National Severe Storms Laboratory; PARC, Palo Alto Research Center; PNNL, Pacific Northwest National Laboratory; PSU, Pennsylvania State University; SNL, Sandia National Laboratories; UBC, University of British Columbia; UM, University of Massachusetts; UoM, University of Maryland; UNAVCO, University NAVSTAR Consortium; USDA, U.S. Department of Agriculture; UU, University of Utah; UW, University of Wisconsin; and WPL, Wave Propagation Laboratory.

[b] Other definitions: AERI, atmospherically emitted radiance interferometer; ARESE, ARM Enhanced Shortwave Experiment; ARM, Atmospheric Radiation Measurement (Program); BAMS, *Bulletin of the American Meteorological Society*; BLX, Boundary Layer EXperiment; CART, Cloud and Radiation Testbed; CASES, Cooperative Atmosphere-Surface Exchange Study; CLEX, Cloud Layer EXperiment; DIAL, DIfferential Absorption Lidar; DSIT, Data and Science Integration Team; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; FDDA, four-dimensional data assimilation; GCIP, GEWEX Continental-Scale International Project; GEWEX, Global Energy and Water Cycle Experiment; GIST, GEWEX Integrated System Test; GPS, global positioning system; IDP, Instrument Development Program; IOP, intensive observation period; IR, infrared; IRF, instantaneous radiative flux; ISS, integrated sounding system; LLJ, Low-Level Jet; LMS, Lockheed Missile and Space; MSX, Midcourse Satellite Experiment; PBL, planetary boundary layer; RASS, radio acoustic sounding system; SCM, single-column model; SGP, Southern Great Plains; SITAC, Spectral Imagery Technology Applications Center; SUCCESS, Subsonic Aircraft: Contrail and Cloud Effects Special Study; TWP, Tropical Western Pacific; UAV, unmanned aerospace vehicle; VORTEX, Verification of the Origins of Rotation in Tornadoes Experiment.

of providing the range and resolution of observations of winds and thermodynamic quantities necessary to estimate these boundary conditions. Because derivatives are needed in both horizontal directions, BBSS data from the central facility and the four boundary facilities are the minimum required for reliable estimates. This IOP will be held from April 14 through May 4, 1997. The surface component of the research will consist of a field observation campaign to provide ground truth for the aircraft and satellite observations. The ARM SGP CART site was deemed the ideal location for the surface campaign.

The Spring 1997 Cloud Radar Validation IOP. The main objective of this IOP is to validate retrieval of cloud microphysics on the basis of the newly acquired ARM zenith-pointing MMCR now installed at the SGP central facility. In addition, the Environmental Technology Laboratory (ETL) plans to operate their scanning NOAA/K-band cloud radar next to the ARM cloud radar to evaluate algorithms that relate temporal cloud variability to spatial cloud variability. The aircraft proposed for this IOP are (1) the North Dakota Citation for high-altitude sampling and (2) the PNNL Gulfstream (G-1) for concurrent low-altitude sampling. The scheduling of this IOP is constrained by the availability of the NOAA/K-band cloud radar. Some aerosol missions are possible to take advantage of clear-sky periods during the aircraft deployment.

The Summer 1997 Single-Column Model IOP. This SCM IOP is identical to the Spring SCM IOP but occurs during the summer season. Although this IOP has always taken place during mid-July through early August, it has tentatively been scheduled to coincide with the SGP '97 (Hydrology) IOP from June 17 to July 11, 1997.

The SGP '97 (Hydrology) IOP. This joint NASA/USDA effort is a hydrology and boundary layer experiment to map out soil moisture at satellite temporal and spatial scales in the SGP. The key remote sensing instrument during SGP '97 will be the L-band electronically scanned thinned-array radiometer aboard a P-3 aircraft. An attempt will be made to carry out a daily soil moisture mapping of the SGP (10,000-km × 10,000-km area) over a period of one month. Crucial to the project are the extensive *in situ* observing programs of the USDA Micronet, the Oklahoma Mesonet (OKM), and the U.S. Department of Energy (DOE) SGP CART site. In addition, data will be validated by a gravimetric sampling program. Recently, a boundary layer component has been added, and a Twin Otter aircraft will provide for area-averaged fluxes within the boundary layer over the southwest section of the SGP CART site domain. This activity is scheduled for June 17-July 11, 1997. Please contact Tom Jackson (USDA) for details at (202) 358-0771 or Ming-Ying Wei (NASA) at (202) 358-0771.

The Fall 1997 Cloud/Aerosol IOP (in conjunction with the Unmanned Aerospace Vehicle [UAV] IOP). The main objective of this IOP is the *in situ* measurement of cloud and aerosol properties in clear and cloudy sky conditions while the ARM UAV high/low set of airborne platforms are measuring radiometric properties. This IOP provides an unprecedented (for ARM) opportunity to quantify cloud and radiation interactions. The aircraft proposed for this IOP is the Wyoming King Air.

The Water Vapor IOP. The next Water Vapor IOP will take place in Fall 1997. The DSIT representative is Dave Turner, and he can be reached at (509) 375-2590.

The Shortwave Radiation IOP. A shortwave radiation IOP is being discussed to be coincident with the UAV and Cloud/Aerosol IOPs. The emphasis would be on spectrally resolved measurements, especially the diffuse component; instrument intercomparison and characterization will also be emphasized.

The Fall 1997 Single-Column Model IOP. This SCM IOP is identical to the summer SCM IOP but will occur during the fall season. This IOP will be scheduled to coincide with the Fall 1997 Cloud/Aerosol, UAV, Water Vapor, and Shortwave Radiation IOPs. The actual dates are still to be determined.

The Midcourse Satellite Experiment IOP. The satellite overflights of the Midcourse Satellite Experiment (MSX) occurred at the CART site on June 17, July 15, August 12, and September 9, 1996. The satellite was launched on April 24, 1996. At least one "staring" experiment was to occur during the first date of each MSX operating month (listed above), when the recorders are clean. This observation may be supported by one or more "limb" scans and one or more "pushbroom" scans. The ARM ground support measurement activities were still being planned as of this writing.

The CO_2 Differential Absorption Lidar IOP. John Jolin, Los Alamos National Laboratory (LANL), anticipates conducting a DOE-funded experiment at the SGP CART site. His experiment uses a 10-kHz tunable-frequency lidar system for the 9- to 11-μm wavelength region of interest. The CO_2 DIfferential Absorption Lidar (DIAL) system can be mounted in aircraft or be ground-based. Currently, the aircraft system is being considered. The CO_2 DIAL system will be used to identify trace chemical species, as well as to measure water vapor. The system on board a U.S. Air Force KC-135 aircraft can be used to make spectrally resolved albedo measurements. A three-week duration in October 1997 is anticipated for the time frame.

5.2 Potential Collaborative Investigations

Argonne National Laboratory is developing a new research facility within the existing boundaries of the SGP CART site, to be devoted to studies of the planetary boundary layer (PBL). The Argonne Boundary Layer Experiment (ABLE) will cover an area approximately 50 km × 50 km within the Walnut River watershed in Butler County, Kansas, about 50 km (30 mi) east of Wichita and near the Towanda extended facility. New techniques of observation and data fusion will be developed and used to study the nocturnal low-level wind maximum and its relation to the synoptic jet features; to develop methods for spatial integration of air-surface exchange of heat, gases, and momentum; and to study horizontal and vertical dispersion in the PBL. The initial set of instrumentation available at the ABLE will include two 915-MHz profilers with RASS, three minisodars, one lidar ceilometer, one BBSS, five surface ECOR flux stations, five soil moisture and temperature stations, five automated weather stations (AWSs), and one satellite data receiver processor. One central location will house data collection equipment and instrumentation and will provide accommodations for visiting scientists. The data obtained will be provided in real time to a user community of atmospheric scientists and ecologists.

The 915-MHz profilers with RASS and the minisodars have been installed at Oxford and Whitewater, Kansas. A minisodar and an AWS have been added to the ARM Program's Beaumont, Kansas, intermediate facility, which is shared by and provides data streams for both the ARM Program and ABLE. In addition, an extensive automated high-spatial-resolution soil moisture and temperature network will be installed and remain in place, located in the Towanda subbasin. A second network (not automated) with larger spacing may also remain in place. All are within the footprint of the Wichita next-generation radar (NEXRAD).

The Cooperative Atmosphere-Surface Exchange Study (CASES) is a collaborative effort to obtain measurements over the entire Walnut River watershed (approximately 100 km × 100 km) in and around Butler County, Kansas, about 50 km (30 mi) east of Wichita. The CASES initiative will obtain measurements over a somewhat larger domain than ABLE. CASES will include hydrologic, ecological, and atmospheric chemistry studies, in addition to ABLE research.

Several principal investigators have been funded as part of CASES to do boundary layer research over the CASES/ABLE domain. The principal contacts for CASES are Peggy LeMone, National Center for Atmospheric Research (NCAR), and Bob Grossman, University of Colorado.

The CASES experiment period is April 22-May 19, 1997, and the types of investigation include the diurnal variation of the PBL for different surface evaporation conditions; validation of the ABLE profilers; surface flux measurements, including CO_2 and O_3; soil moisture measurements; validation of radar rainfall estimates; boundary layer flux measurements; low-level jet studies; etc. The types of instrumentation include eight surface flux stations and the air-surface turbulence exchange research (ASTER) system; the University of Wyoming King Air and NOAA Twin Otter CO_2 and O_3 flux instruments; a 35 tipping-bucket raingauge network and 20 sites for manual time-domain refractometry to get soil moisture within the Wichita NEXRAD radar footprint; a 10-cm polarization radar; an all-sky camera; and three cross-chain loran atmospheric sounding systems (CLASSs).

5.3 Design of Intensive Observation Periods

The initial design of most of the special operations is in the hands of the DSIT. Prototype procedures to facilitate the design, review, and implementation processes are specified for the planning of IOPs. Examples of such plans were included in Appendices A and B of Schneider et al. (1993). Similar documents are prepared by Campaign Team leaders to facilitate interagency collaborations and by Operations Team leaders to facilitate the use of guest instruments. The SST and the site program manager assist the DSIT in the generation of plans for special operations, including the plans for newly approved QMEs, IOPs, and campaigns in the *Site Scientific Mission Plan*, and assist in the execution of special operations. With the many-month lead time necessary to schedule research aircraft, the design of special operations involving aircraft should begin more than a year before the projected operation and should be sufficiently complete to be included in collaborative proposals.

5.4 Quality Measurement Experiments

As discussed in Section 4.3, QMEs are investigations designed to enhance the ARM data quality by providing information derived from a continuous intercomparison of alternative measurements or models of observed geophysical quantities. During this six-month period, a high priority will again be given to comparisons of similar data streams from different instrument packages, a natural and obvious complement to the efforts of the instrument mentors. A number of QMEs developed by instrument mentors, the SST, or the DSIT will be conducted by employing routine observations.

Examples of QMEs include the ongoing comparisons of (1) the AERI spectral radiances with the values calculated via the line-by-line radiative transfer model (LBLRTM) and (2) the integrated columnar water vapor measured by the MWR with that calculated from the vertical integration of water vapor estimates from the BBSS and Raman lidar. Prospective QMEs include comparison of (1) water vapor profiles retrieved from the MWR with the BBSS and Raman lidar moisture profiles; (2) the brightness temperatures observed by the MWR with values calculated by using the LBLRTM at the specific wave numbers at which the MWR operates; (3) cloud base heights derived from the BLC, MPL, and Raman lidar with cloud base heights derived from other cloud radars as available; (4) the observed to calculated broadband radiative surface fluxes; (5) virtual temperature and velocity profiles from the BBSS with data from the 915- and 50-MHz profilers and Raman lidar; (6) temperature, humidity, and pressure measurements from the SMOSs with those from the 25-m and 60-m levels on the 60-m tower and the EBBR system; and (7) momentum, heat, and moisture fluxes derived from the EBBR with those from ECOR systems. Many such studies under consideration would help to evaluate the vendor-specified operating ranges, as well as the precision and accuracy of the CART instruments.

5.5 Value-Added Products

The VAPs Working Group provides a mechanism for generating scientifically useful data sets (including products from QMEs) of geophysical quantities that are important to the ARM Program, including the SGP site. Value-added products are second-generation data streams derived by applying algorithms to existing data streams. The VAPs Working Group is composed of scientists from the DSIT, IT, and SST. The group is dedicated to data quality issues. Its tasks are to prioritize the creation of products focused on key geophysical quantities and to facilitate the implementation of procedures to generate such products. The results of these efforts, including the results of QMEs, will have both short- and long-term effects on the ARM data stream and on site management, including advisories to the Science Team concerning data quality, modifications in strategies for data acquisition, and reassessments of measurement algorithms. The unique and most important of the instrument comparisons will be distributed as internal ARM reports and submitted for publication in appropriate peer-reviewed journals.

5.6 Geophysically Significant Phenomena

The ARM Program has transitioned toward the GVFA, which focuses on the study of geophysically significant phenomena (e.g., water vapor profiles, aerosols, clouds, temperature profiles, and radiation). Algorithm development that describes these phenomena is a current primary focus.

The algorithm products represent a merging of appropriate instrument measurements into a cohesive product defining a particular geophysical state, for use by the Science Team. These products specifically address problems posed in the *Science Plan* and by various working groups. A product currently under discussion is one prescribing water vapor over the SGP CART site sought by the IRF Working Group. As noted above, such an effort will involve three IOPs obtaining multiple water vapor measurements at the central facility (e.g., additional measurements on the 60-m tower; use of a tethersonde system; use of guest instruments and additional instruments, such as chilled mirrors and frost-point hygrometers) and comparison of these measurements with routine BBSS, Raman lidar, MWR, and 915- and 50-MHz RASS water vapor profiles. The end result of such comparisons will be the generation of an ensemble, site-representative water vapor profile for use in GCMs. The first such Water Vapor IOP occurred in September 1996.

5.7 Educational Outreach

The educational outreach program for the SGP CART site, coordinated by Dr. Ken Crawford, Director of the Oklahoma Climatological Survey (OCS), combines a range of resources available at OU. Outreach efforts are focused at the precollege, undergraduate, and graduate levels. Efforts in this six-month period continue to be focused on integration of ARM and NWS data (as nearly in real time as possible) into the EARTHSTORM project, a program conducted by the OCS to integrate real-time data into classroom activities in kindergarten through grade 12 (McPherson and Crawford 1996). The EARTHSTORM project currently accesses data from the OKM, a high-density network of surface meteorological stations, and provides the data to students in real time. EARTHSTORM has created learning modules and has provided teacher workshops to enhance the use of OKM data. Extension of these activities to include SGP ARM data is now beginning to occur at a significant level. In addition, an ARM/Kansas teachers' workshop will take place at OU in July 1997. Further extension of these efforts to the Tropical Western Pacific and North Slope of Alaska ARM sites will be investigated.

5.8 Water Vapor Intensive Observation Period

September 10-30, 1996, saw the first of three planned Water Vapor IOPs at the central facility. New technologies were applied to improve water vapor observations in the lowest kilometer of the atmosphere. Atmospheric conditions cooperated to provide sampling of an order-of-magnitude variation in total water content, and instrument reliability was very good.

The effort is important for climate studies and could have significant implications for weather applications as well. Water vapor, the dominant form of atmospheric water, affects the climate by controlling both emitted radiation (as the primary greenhouse gas) and reflected solar radiation (as the source of material for cloud particle formation). The first IOP was specifically motivated by the goal of reducing the uncertainties in the water vapor observations that are integral to ARM spectroscopic analyses, contributing to better radiative transfer calculations for climate models.

An unprecedented complement of instrumentation for both *in situ* and remote sensing observations of water vapor profiles and precipitable water were deployed. The extensive SGP CART site facilities that run continuously were augmented by instruments assembled from outlying SGP CART site locations and by a diverse assortment brought to the site for the IOP. The idea was to learn how to make better use of the instrumentation normally present at the SGP CART site by making intercomparisons of similar instruments and by using highly accurate research grade observations to provide absolute calibration.

One of the newest ARM capabilities is the CART Raman lidar, an active remote sensing system which provides frequent altitude profiles of water vapor mixing ratio by pointing an ultraviolet lidar beam to the zenith and detecting the Raman backscattered return from atmospheric water vapor and nitrogen. The system ran nearly continuously throughout the 21 days of the IOP, providing profiles up to about 5 km during the day as well as up to 9 km at night. The NASA Goddard Raman lidar, the model for a new ARM system, was also present for intercomparison and to offer an enhanced sensitivity near the surface by scanning the lidar off zenith. The two Raman lidar systems proved to be quite stable, showed very good agreement with each other, and often agreed with the fine scale vertical structure in balloon-borne *in situ* observations. Establishment of absolute calibration techniques and of stability characterization was one of the important goals of the IOP.

Remotely sensed water vapor profiles (plus temperature profiles) are also provided up to about 3 km at the SGP CART site every 10 minutes, 24 hours per day, by the AERI, a passive system. During the IOP, the operational AERI showed excellent agreement with the prototype AERI system brought to the site by the University of Wisconsin. The AERI systems measure spectrally resolved downwelling IR radiance (520 to 3,020 cm^{-1}), from which moderate vertical resolution profiles are derived. The accurately calibrated radiances from the AERI also serve as reference spectra to help improve atmospheric radiative transfer calculations for both clear and cloudy skies.

Probably the largest collection of passive microwave instruments ever assembled was compared during the IOP to test the hypothesis that accurately calibrated observations of the 22-GHz water vapor absorption line can provide a strong constraint on total precipitable water for use in calibrating radiosonde and Raman lidar systems. The collection included eight CART 2-channel MWRs (23.8/31.4-GHz systems) collected together at the central facility, two 2-channel radiometer systems from the NOAA ETL in Boulder, Colorado (23.8/31.65 GHz and 20.65/31.65 GHz), a multichannel system from the University of Massachusetts (16 channels on the 22-GHz line + 32 GHz), and two multichannel systems from the NASA Goddard Space Flight Center (advanced multispectral microwave radar [AMMR], 21/37/92 GHz; and microwave imaging radar [MIR], 89/150/183/220 GHz). In addition, a GPS active microwave device from the NOAA Forecast Systems Laboratory was located at the central facility (11 others in the complete SGP CART site) to provide determination of total precipitable water. Further instrumentation capable of determining columnar water vapor from solar observations included the MFRSR, the rotating shadowband spectrometer, and a CSPHOT.

Traditional systems for water vapor measurement included the BBSS, with balloons launched every three hours, plus several stationary *in situ* sensors. About half of the BBSS launches made use of dual-sensor packages (Vaisala RS-80s) for calibration intercomparisons, and all flights were analyzed on two separate data systems to compare software differences. The central facility 60-m level and the SGP CART site surface temperature and humidity probes located on the SMOS were augmented with additional instrumentation. These instruments included temperature and humidity sensors from OU and the National Severe Storms Laboratory (NSSL) at the 25-m level of the tower, two systems at the 60-m level, and one at the SMOS location, plus a new sensor at the BBSS launch site. The OU/NSSL sensors and some of the CART sensors were compared with state-of-the-art chilled-mirror hygrometers before and after the IOP in a humidity-controlled apparatus at the OKM laboratory. This comparison allowed for the transfer of a NIST traceable standard (the chilled-mirror hygrometers) to the standard relative humidity probes (capacitance-based).

Chilled-mirror sensors flown on a wide variety of unusual platforms during the IOP are expected to serve the key role of establishing high-absolute-accuracy reference profiles in the lower atmosphere. The primary platform was a tethered balloon system (operated by LANL) that carried lightweight chilled-mirror systems from Switzerland. Many successful studies were conducted to altitudes between 500 m and 1 km, under conditions of relativity light winds (<7-10 m/s). The same chilled-mirror systems also underwent several successful tests on a University of Colorado kite system that offers flight opportunities during stronger winds (5-20 m/s) and potentially for higher altitudes in the future. The IOP was also coordinated with a field campaign of the ARM UAV Program that included aircraft-based chilled-mirror instrumentation. The UAV experiment involved both the Altus UAV from General Atomics and the Ross Aviation Twin Otter aircraft flown to escort the Altus. Both carried chilled-mirror sensors (the Altus, technically a frost-point instrument because of its cryogenic cooling capability) that were flown over the central facility several times (seven Twin Otter and three Altus flights). The initial agreement among the various chilled-mirror sensors was encouraging, although postexperimental calibration activities are still underway.

Some of the major real-time findings of the IOP involved discrepancies with the "standard" *in situ* sensors. Comparisons with the OU/NSSL sensors and assessment of AERI boundary layer conditions identified possible inconsistencies with the standard CART *in situ* sensors on both the 60-m tower and on the SMOS. These findings will help to explain some of the large diurnal anomalies encountered when comparing sonde and tower observations before the Water Vapor IOP. Other important issues with sonde-tower intercomparisons were identified with sonde pressure-sensor launch anomalies and the associated processing. These anomalies often cause altitude jumps of several tens of meters, sometimes getting larger than 100 m. Tentative solutions to these sonde issues were identified.

6 DISTRIBUTION OF DATA

Most of the data being requested are received from the SGP CART site or external data sources and are then repackaged for daily and weekly distribution to individual users. In some cases, users can log into the Experiment Center and extract data by anonymous file transfer protocol (FTP). The Experiment Center has developed a method to track the progress of data streams, which has been partially reproduced in Appendix A, Table A.6. The information provided includes the name of the instrument base or the source of the external data set, the name of the data stream, the status of data availability, whether the individual data stream is ingested, the number of people who have requested the data, and the person responsible for releasing the data and periodically checking the data stream quality. A yes (Y) in the "Ingested" column means that data streams are available, that an ingestion program has been written for the data stream, and that the data are of sufficient quality to be releasable.

The status of data streams from CART instruments or external sources has been classified as releasable (released upon request for the data stream), developmental (released only to SDS personnel for development of ingestion programs), under evaluation (released to an investigator for an initial data quality check), beta release (for releasable data of known and reasonable quality), collecting (when raw data are being collected for future processing and distribution), mentor only (when the data stream is provided only to the instrument mentor at the request of the mentor), analysis (if the data stream is released for further processing and/or analysis, such as for graphic display), or defunct (due to replacement of a prototype instrument data stream with the CART instrument data stream).

7 LOOKING AHEAD

The nearly fully mature SGP CART site now provides the full range of data streams needed to support the DSIT's "building block" algorithm development effort and a broad spectrum of Science Team research. These activities, in turn, are increasingly drawing on multiple SGP data streams to focus strongly on geophysically significant phenomena (water vapor profiles, clouds, aerosols, temperature profiles, radiation). The operational challenges that will be of greatest importance during the last half of 1997 and 1998 will therefore include maintaining the performance of the basic instrumentation suite at the highest possible level, improving that performance where possible, enhancing the original CART design through the permanent addition of new instruments, and mounting focused IOPs involving temporary additional instrumentation. Through this mix of activities, the evolving scientific requirements, challenges, and opportunities for the SGP CART will be met. The present chapter outlines the path ahead, to the extent that it can be identified in early 1997.

The key developments that are expected to occur at the central facility during the present six-month period and the following 18 months include the achievement of the routine, unattended, continuous operation of the Raman lidar; initial operation of the newly installed IDP MMCR; early use of the recently completed RCF; upgrading of the Vaisala BBSS sondes (see below); and the installation of several new instruments (AERI X, CSPHOT, video time-lapse sky camera, SORTI 01, UV-B sensor, photosynthetically active radiation sensor [PAR], optical transmissometer, and some type of Vaisala ceilometer). These developments will support a more complete specification of the radiative state of the lower atmosphere, particularly if (1) the planned series of three Water Vapor IOPs (which began in September 1996 and will extend into 1997 and 1998; see below) yields procedures to independently make accurate measurements of the water vapor distribution in the lowest kilometer of the atmosphere and (2) a counterpart temperature profiling capability is also produced. In addition, 1997 may also see the implementation of some type of solar spectral radiometer to provide solar spectral observations at the central facility that are needed for the testing and improving of solar radiation models. A zenith sky radiance sensor in the near-IR has also been suggested for that location. The sensor would have the advantage of a field of view that overlaps or nearly coincides with those of the MWR and possibly MMCR.

During the planned second (fall 1997) and third (1998) Water Vapor IOPs, the tropospheric water vapor profile will continue to be intensively quantified at the central facility by using a full range of state-of-the-science instrumentation. For the initial Water Vapor IOP (fall 1996), this instrumentation included a second Raman lidar; multiple MWRs and BBSSs; tethersonde and kite systems; additional sensors (including chilled-mirror hygrometers) on the 60-m tower at the 25-m level; fixed-sensor temperature, relative humidity, and surface pressure measurements near the BBSS launch point; and use of the OKM reference chilled-mirror hygrometer and associated calibration facility. This unprecedented observational capability was focused on the atmosphere's lowest few hundred meters in particular, and its data (still being analyzed) will help guide the development of the aforementioned two follow-up IOPs. The scope of the second Water Vapor IOP will extend to higher-altitude water vapor distributions through a greater use of aircraft- and UAV-mounted sensors. The temperature and humidity profiles that are routinely generated by the AERI instrumentation at the central facility will also contribute to the needed enhanced specification of the lower atmosphere during late 1997 and 1998.

The utility of the Raman lidar in this context—to characterize the lower half of the troposphere (e.g., water vapor, clouds, aerosols) more accurately and with a finer vertical resolution than is possible with the existing suite of instruments (BBSSs, MWRs)—has been strongly advocated by the IRF Working Group. The routine, unattended, continuous operation of the Raman lidar should occur in the near future, following the installation of a permanent hail shield. This pioneering achievement will be the result of 12 months of intensive effort by the instrument mentor and site operations, during which a number of challenging hurdles were surmounted. Also, the recent installation of the MMCR will soon enhance the ongoing efforts of the VAPs Working Group to improve the definition of cloud characteristics (fractional coverage, as well as base and top heights) above the central facility, in coordination with key Science Team members. The MMCR is equipped to map the vertical extent of cloud boundaries up to a height of approximately 20 km. Coincident measurements of vertical wind speed will be obtained from Doppler analysis. The system will operate only in the vertically pointing position.

Improved specifications of the water vapor, temperature, and cloud conditions above the boundary facilities are expected to result from several observational enhancements and additions during 1997. First, the addition of ceilometers is primarily intended to provide data for algorithms that will retrieve lower tropospheric temperature and humidity profiles from the output of new, collocated AERI instruments. Second, higher quality BBSS soundings should result from the upgrade of the Vaisala sensors being used (from RS-80 to RS-90). The RS-90 humidity sensor has a faster response time and thus recovers more quickly than its predeccessor after emerging from clouds. Its temperature counterpart is also smaller and has a faster response time than the RS-80 and, in addition, is less susceptible to solar heating. An identical BBSS upgrade will occur at the central facility.

By the end of 1997, with the completion of extended facilities at Seminole (over pasture) and El Reno (pasture) and at a wooded Okmulgee site, the basis for the spatial integration of the turbulent and radiative fluxes over the entire SGP CART site will have been firmly established through the completion (according to their original design) and upgrading of all 23 extended facilities. A key feature of that upgrading is the ongoing addition of SWATS to all extended facilities. The SWATS data will contribute significantly to completing the characterization of the land surface and subsurface that is essential for investigating surface heat and moisture exchanges. In a closely related development, approximately 40 additional identical SWATS systems are being installed at OKM sites within the SGP CART site domain during a two-year period that began in mid-1996. The SWATS systems that exist in midsummer 1997 (approximately 40) will be the centerpiece of an ARM/USDA/NASA Hydrology IOP that is now being planned for that period, which will also make use of satellite and aircraft data and focus in particular on soil moisture. The second half of 1997 should see the completion of improved SIROS data logging at the central and extended facilities. This improvement is involving both (1) the introduction of independent data logging systems for the SIROS broadband sensors, which will henceforth be known as SIRSs (solar and infrared stations), and (2) the MFRSRs becoming the sole users of the original systems that were previously shared with the SIROS instrument suites. Improved reliability of the SIROS/SIRS data gathering should result. A similar logging system subsequently will be introduced for the BSRN (to be renamed BRS [broadband radiometer station]). The capability for monitoring land-atmosphere interactions recently was enhanced further with the establishment and operation of three ARM intermediate facilities containing 915-MHz profilers with RASS, which are being used to quantify structures and processes in the PBL. Stabilization of these systems will occur during 1997. Significant scientific dividends from all of the above substantial surface and boundary layer measurement enhancements will begin to accrue in late 1997 and 1998.

The SGP CART site activities during late 1997 and 1998 will continue to capitalize on the 1996 installation of the aerosol instrumentation and the RCF at the central facility. The data from the aerosol instruments will fill a significant gap in the specification of the radiative state of the near-surface atmosphere. Indeed, the importance for ARM of aerosol effects is likely to grow in the next two years. The establishment of the RCF is a key element in the total quality control effort addressing the wide variety of radiometers at the central facility and the more limited SIROS/SIRS radiometer suites at the extended facilities. Establishment of the RCF was accomplished during the latter half of 1996 and will be augmented by the development and implementation of a comprehensive integrated RCF Operations Plan as the SGP CART site moves from the establishment of routine operations to the maintenance of routine operations, with inherent instrument-aging problems. The SST will continue to assist in the calibration and maintenance areas during 1997-1998, when it will also contribute further to the quality control and assurance of the ever-expanding SGP CART data bank through the further development and use of graphic data quality display modules and performance metrics. As noted in earlier chapters, the graphic displays, which plot actual data against modeled expectations, are intended for use by site operations staff (and the SST) to aid in their efforts to perform "first-line-of-defense" near-real-time quality assurance relative to instrument operation. The performance metrics are intended to give a broader view of instrument performance and data quality over the CART site relative to how data fall within or outside of specified quality tolerances, such as range and consistency checks, and already include platform intercomparisons. Both efforts represent a major step forward toward achieving a comprehensive end-to-end quality control system for instrument performance and data.

During 1997 and 1998, the SGP CART site observational capabilities are expected to continue to benefit from ongoing interactions between the ARM Program and several other federal and state research programs having an interest in the SGP in general. The federal agency interactions, which until now have particularly involved the GCIP component of GEWEX, are currently being broadened through the leadership of NASA and the USDA in the aforementioned midsummer 1997 Hydrology IOP. These interactions are also currently manifest in the approximately biannual meeting of a joint ARM-GCIP-ISLSCP Working Group (on which ARM is represented by J.C. Doran, R.G. Ellingson, and P.J. Lamb); the aforementioned implementation of the SWATS at the ARM extended facilities, with significant financial support from GCIP; and the USDA's facilitation and partial funding of the above El Reno extended facility. The Joint Working Group will be concerned not only with fostering the most cost-effective and efficient observational strategies for the SGP CART site for 1997 and 1998 and subsequent years, but also with formulating the best possible scientific use of the resulting data among their programs. Consistent with this latter goal, the Working Group's May 1997 meeting will focus on "Value Added Science." Interactions with the OKM, which has been an important source of external data for the SGP for several years, are expected to increase with the OKM's aforementioned parallel deployment of approximately 40 SWATS systems. Finally, a joint effort between the NWS and ARM is now resulting in ARM rawinsonde data being made available to the meteorological community at large via the Global Telecommunications System.

This availability will be especially valuable for the NWS short-range prediction efforts during the tornado seasons of the next few years.

The integration of ARM UAV operations into the SGP CART site scientific mission was initiated successfully during the April 1994 IOP, which used a small UAV (GNAT) that could ascend only to 6.7 km (about 22,000 ft). However, delays in developing, testing, and gaining operational approval for the larger UAVs needed for radiation measurements at higher elevations precluded their subsequent use over the SGP CART site for the next two years. Manned aircraft were used instead, as during the ARESE IOP. Fortunately, this situation was rectified with the deployment of the Altus UAV during the September 1996 Water Vapor IOP, which permitted the valuable operation of highly stable UAV-mounted radiation and other instruments over the SGP CART site. Indeed, this operation constituted a great step forward for the use of UAVs in scientific research in general because it included a record-breaking 26-hour mission. The use of UAVs is therefore expected to be an essential ingredient of some future IOPs, such as the combined second Water Vapor/first Shortwave Radiation/Aerosol/Cloud IOP planned for fall 1997. Planning for this large IOP is now just beginning. All UAV operations will be supported by climatological analyses by the SST of historical cloud and wind data for the SGP vicinity.

Throughout 1997, the scientific operation of the SGP CART site should begin to benefit significantly from guidance provided by the SAC. This dividend is likely to grow during the following two years. The fundamental role of the SAC is to ensure that the operation of the site addresses the goals and objectives of the ARM Program (published in the 1996 *Science Plan*) to the fullest possible extent, including through successful adaptation to changing circumstances and opportunities. Such performance will ensure that the flows of data to the Science Team members are appropriate to their needs, of consistently high quality, and as continuous as possible. For example, the recent redoubling of efforts by the SST to help ensure the quality of SGP data is consistent with the strong encouragement offered by the November 1995 SAC Review. Because the membership of the SAC is divided approximately equally between ARM Science Team members and nonmembers, its guidance reflects both the inherently more parochial concerns of the ARM Science Team and the broader global-change perspective of the others. The recommendations from the November 1995 SAC meeting are now being acted upon by the SST and will be reflected in the scientific capability of the site during 1997 and 1998. Those recommendations included the aforementioned need for increased attention to quality assurance and quality control of the SGP instruments and data streams, the necessity of making midcourse corrections (including those of personnel assignments and funding priorities) to ensure that the configuration and operation of the SGP CART site are in full consonance with the

ARM *Science Plan* priorities, the desirability of converting the *Site Scientific Mission Plan* into an article for publication in the *Bulletin of the American Meteorological Society* that would publicize the scientific potential of the site; and the inauguration of an SST "Visitor Program" that would particularly involve cloud and radiation data analyses and simulations with the goal of enhancing the site's observational capabilities in those crucial areas. The recommendations from a follow-up June 1996 SAC review of the SST’s research program and its interactions with the site program manager and site operations manager will be received during early 1997. Thus, from now onward, the SAC guidance will have a continuing effect on the scientific mission of the SGP CART site. This fact, coupled with the recent nearly full maturation of the site, should result in optimal operation of this ARM locale with respect to the goals and objectives of the overall ARM Program during the second half of 1997 and 1998.

8 REFERENCES

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APPENDIX A:

STATUS AND LOCATIONS OF INSTRUMENTS AND DATA STREAMS

TABLE A.1 Actual and Planned Locations of Instruments at the Central Facility[a]

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
AERI	36.967 N 97.528 W	Pasture	Optical trailer	—
AERI X	36.967 N 97.528 W	Pasture	Optical trailer	Not installed
SORTI	36.967 N 97.528 W	Pasture	Optical trailer	—
BSRN	36.993 N 97.708 W	Pasture	Central cluster	—
BRS	36.993 N 97.708 W	Pasture	Central cluster	—
SIROS	36.993 N 97.708 W	Pasture	Central cluster	—
SIRS	36.993 N 97.708 W	Pasture	Central cluster	—
UV-B	36.993 N 97.708 W	Pasture	Central cluster	Not installed
PAR	36.993 N 97.708 W	Pasture	Central cluster	Not installed
10-m MFR	36.785 N 97.665 W	Pasture	Central cluster	—
25-m USR	36.932 N 97.916 W	Wheat	60-m tower	—
25-m UIR	36.932 N 97.916 W	Wheat	60-m tower	—
25-m MFR	36.932 N 97.916 W	Wheat	60-m tower	—
CSPHOT	36.967 N 97.528 W	Pasture	Optical trailer	Not installed
BBSS	37.012 N 98.120 W	Grass	Central compound	—

TABLE A.1 (Cont.)

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
915-MHz RWP	36.677 N 97.686 W	Shale, pasture	Profiler trailer	—
50-MHz RWP	36.630 N 97.706 W	Shale, pasture	Profiler trailer	—
MWR	37.105 N 97.765 W	Pasture	Optical trailer	—
RLID	38.052 N 97.741 W	Pasture, wheat	IDP 3	—
WSI	36.842 N 97.608 W	Pasture	Optical trailer	—
BLC	36.697 N 97.528 W	Pasture	Optical trailer	—
MPL	36.967 N 97.528 W	Pasture	Optical trailer	—
MMCR	36.885 N 97.591 W	Pasture, wheat	IDP 2	—
Vceil	37.105 N 97.765 W	Pasture	Optical trailer	—
SVC	37.105 N 97.795 W	Pasture	Optical trailer	Not installed
25-m T/RH	36.932 N 97.916 W	Wheat	60-m tower	—
60-m T/RH	36.932 N 97.916 W	Wheat	60-m tower	—
ECOR	36.857 N 97.631 W	Wheat, pasture	Aerosol trailer	—
25-m ECOR	36.932 N 97.916 W	Wheat	60-m tower	—
60-m ECOR	36.932 N 97.916 W	Wheat	60-m tower	—

TABLE A.1 (Cont.)

Instrument	Latitude, Longitude (deg)	Surface Type	Location	Comments
EBBR	36.887 N 97.531 W	Pasture	Central cluster	—
SMOS	36.785 N 97.665 W	Pasture	Central cluster	—
AOS	36.927 N 97.828 W	Pasture, wheat	Aerosol trailer	—
RCF	36.958 N 97.653 W	Pasture, wheat	Calibration trailer	—

[a] AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; BRS, broadband radiometer station; BSRN, Baseline Surface Radiation Network; CSPHOT, Cimel sunphotometer; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; MFR, multifilter radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; PAR, photosynthetically active radiometer; RCF, radiometer calibration facility; RLID, Raman lidar; RWP, radar wind profiler; SIROS, solar and infrared radiation observing system; SIRS, solar and infrared station; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SVC, sky video camera; T/RH, temperature and relative humidity sensor; UIR, upwelling infrared radiometer; USR, upwelling solar radiometer; UV-B, ultraviolet B; Vceil, Vaisala ceilometer; WSI, whole-sky imager.

TABLE A.2 Locations and Status of Extended Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS/ SIRS[c]	Comment
Larned, KS EF-1	632	38.202 N 99.316 W	Wheat	ECOR 9/1/95	Yes 6/96	Yes 9/1/95	Yes 9/1/95	Power and comm center installed 10/95
Hillsboro, KS EF-2	450	38.306 N 97.301 W	Pasture	EBBR 10/96	Yes 6/96	No	Yes 9/7/95	Power and comm center installed 8/95
LeRoy, KS EF-3	338	38.201 N 95.597 W	Wheat and soybeans (rotated)	ECOR 12/7/95	Yes 9/96	Yes 12/7/95	Yes 12/7/95	Power and comm center installed 9/95
Plevna, KS EF-4	513	37.953 N 98.329 W	Rangeland (ungrazed)	EBBR 4/3/93	Yes 3/5/96	Yes 3/28/95	Yes 3/28/95	Power and comm center installed 3/95
Halstead, KS EF-5	440	38.114 N 97.513 W	Wheat	ECOR 1997	Yes 9/96	Yes 5/31/96	Yes; broad-band only 5/31/96	Power and comm center installed 11/95
Towanda, KS EF-6	409	37.842 N 97.020 W	Alfalfa	ECOR 12/14/95	Yes 9/96	Yes 12/14/95	Yes 12/14/95	Power and comm center installed 8/95
Elk Falls, KS EF-7	283	37.383 N 96.180 W	Pasture	EBBR 8/29/93	Yes 3/12/96	Yes 3/9/95	Yes 3/9/95	Power and commu center installed 2/95
Coldwater, KS EF-8	664	37.333 N 99.309 W	Rangeland (grazed)	EBBR 12/8/92	Yes 6/96	Yes 3/4/93	Yes 5/9/95	Power and comm center installed 5/95
Ashton, KS EF-9	386	37.133 N 97.266 W	Pasture	EBBR 12/10/92	Yes 2/27/96	Yes 3/13/90	Yes 10/5/93	Power and comm center installed 10/93
Tyro, KS EF-10	248	37.068 N 95.788 W	Wheat	ECOR 7/21/95	Yes 7/96	No	Yes 7/21/95	Power and comm center installed 6/95

TABLE A.2 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS/ SIRS[c]	Comment
Byron, OK EF-11	360	36.881 N 98.285 W	Alfalfa	ECOR 6/26/95	Yes 6/96	Yes 6/26/95	Yes 6/26/95	Power and comm center installed 6/95
Pawhuska, OK EF-12	331	36.841 N 96.427 W	Native prairie	EBBR 8/29/93	Yes 9/97	No	Yes 6/30/95	Power and comm center installed 6/95
Lamont, OK EF-13, 14	318	36.605 N 97.485 W	Pasture, wheat	EBBR 9/14/92 ECOR 5/30/95	Yes 2/5/96	Yes 4/9/93	Yes 10/15/93 BSRN 5/15/92	Power and comm center installed 6/93
Ringwood, OK EF-15	418	36.431 N 98.284 W	Pasture	EBBR 9/16/92	Yes 2/21/96	Yes 3/29/93	Yes 10/12/93	Power and comm center installed 10/93
Vici, OK EF-16	602	36.061 N 99.134 W	Wheat	ECOR 5/30/95	Yes 7/96	No	Yes 5/30/95	Power and comm center installed 5/95
EF-17[d]	—	—	—	—	—	—	—	—
Morris, OK EF-18	217	35.687 N 97.856 W	Pasture (ungrazed)	EBBR 7/97	Yes 9/96	No	Yes; broad-band only 5/24/96	Power and comm center installed 10/95
El Reno, OK EF-19	—	—	Pasture (ungrazed)	EBBR	Yes	No	Yes	To be implemented in 5/97
Meeker, OK EF-20	309	35.564 N 96.988 W	Pasture	EBBR 4/5/93	Yes 2/8/96	Yes 4/2/93	Yes	Power and comm center installed 10/94
Okmulgee, OK EF-21	—	Location identified	Forest	ECOR 4/97	Yes 4/97	Yes 4/97	Yes 4/97	Lease signed 2/97

TABLE A.2 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	Flux Station[c]	SWATS[c]	SMOS[c]	SIROS/ SIRS[c]	Comment
Cordell, OK EF-22	465	35.354 N 98.977 W	Rangeland (grazed)	EBBR 4/5/93	Yes 2/15/96	No	Yes 4/26/95	Power and comm center installed 3/95
Ft. Cobb, OK EF-23	415	35.153 N 98.461 W	Peanuts (irrigated)	ECOR 12/96	Yes 12/96	No	Yes 12/96	No lease agreement
Cyril, OK EF-24	409	34.883 N 98.205 W	Wheat (gypsum hill)	ECOR 8/25/95	Yes 7/96	Yes 8/25/95	Yes 8/25/95	Power and communication center installed 7/95
Seminole, OK EF-25	277	35.245 N 96.736 W	Pasture	EBBR 12/97	Yes 12/97	Yes 12/97	Yes 12/97	Power and communication center installed 11/96
Cement, OK EF-26	400	34.957 N 98.076 W	Pasture	EBBR 6/10/92	—	No	No	Phone line (only) installed 10/92

[a] BSRN, Baseline Surface Radiation Network; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; EF, extended facility; NEPA, National Environmental Policy Act; SIROS, solar and infrared radiation observing system; SIRS, solar and infrared station; SMOS, surface meteorological observation station; SWATS, soil water and temperature system.

[b] Above sea level.

[c] Date indicates actual or scheduled installation date.

[d] This extended facility is a placeholder.

TABLE A.3 Locations and Status of Intermediate Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	915-MHz Profiler and RASS[c]	Comment
Beaumont, KS IF-1	525	37.626 N 96.538 W	Rangeland	Yes 9/96	Power and comm installed 9/96
Medicine Lodge, KS IF-2	585	37.280 N 98.933 W	Rangeland	Yes 9/96	Power and comm installed 9/96
Meeker, OK IF-3	300	35.550 N 96.920 W	Grass	Yes 9/96	Power and comm installed 9/96

[a] IF, intermediate facility; RASS, radio acoustic sounding system.

[b] Above sea level.

[c] Date indicates actual installation date.

TABLE A.4 Locations and Status of Boundary Facilities[a]

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	BBSS[c]	MWR[c]	AERI	Comment
Hillsboro, KS BF-1	441	36.071 N 99.218 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93
Hillsboro, KS BF-1	447	38.305 N 97.301 W	Grass	Yes 9/28/94	Yes 9/28/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
BF-2	—	Un-specified	—	—	—	No	—
BF-3	—	Un-specified	—	—	—	No	—
Vici, OK BF-4	648	36.071 N 99.218 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93
Vici, OK BF-4	622	36.071 N 99.204 W	Grass	Yes 10/3/94	Yes 10/3/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
Morris, OK BF-5	18	35.682 N 95.862 W	Grass	Yes 1/18/94	Yes 1/18/94	No	Temporary power and communication installed 12/93

TABLE A.4 (Cont.)

Site	Elevation[b] (m)	Latitude, Longitude (deg)	Surface Type	BBSS[c]	MWR[c]	AERI	Comment
Morris, OK BF-5	217	35.688 N 95.856 W	Grass	Yes 10/6/94	Yes 10/6/94	No	Relocation and temporary power and communication installed 9/94; permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96
Purcell, OK BF-6	344	34.969 N 97.415 W	Grass	Yes 9/23/94	Yes 9/23/94	No	Permanent power, communication, and grounding mat installed 3/96; T-1 line installed 4/96

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BF, boundary facility; MWR, microwave radiometer.

[b] Above sea level.

[c] Date indicates actual installation date.

TABLE A.5 Status of SGP CART Instrumentation by June 30, 1997[a]

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
AERI 00	IDP prototype	3/18/93	3/18/93	No	Removed 4/95
AERI 01	CART	5/1/95	5/17/95	Yes	No
Aerosol facility	CART	10/23/95	1/19/95	No	Yes
BBSS Digi-Cora	CART	3/15/93	4/15/93	Yes	—
BBSS PC Cora	CART	3/15/92	1/27/93	Yes	—
BLC	CART	3/15/93	5/19/95	Yes	—
EBBR	CART	11/24/92	11/24/92	Yes	—
C1 (60-m tower) ECOR	CART	Pending	—	—	—
C2 (3-m tower) ECOR	CART	5/16/95	5/18/95	No	Yes
C3 (mobile system) ECOR	CART	3/15/95	10/12/95	No	No
10-m MFR	CART	9/15/93	5/22/95	Yes	—
25-m MFR	CART	9/15/93	5/22/95	Yes	—
MMCR	CART	1/30/96	3/27/97	No	Yes
MPL 00	IDP prototype	9/15/93	5/22/95	No	Yes
MPL 02	CART	9/13/95	10/12/95	No	No
MWR	CART	11/2/92	5/17/95	Yes	—
Raman lidar	IDP/CART	9/15/95	4/3/95	Yes	—
RCF	CART	5/24/96	—	—	—
SIROS	CART	9/15/93	5/17/95	Yes	—
SIRS	CART	—	—	—	—

TABLE A.5 (Cont.)

Instrument System	Instrument Class	Installation Date	ORR Date	Full Handoff	Degraded Operations
SMOS	CART	6/10/93	6/10/93	Yes	—
SORTI 00	IDP	1/15/93	1/15/93	No	Yes
SORTI 01	CART	1/15/96	—	—	—
SWATS	CART	1/15/96	3/28/97	Yes	No
WSI 00	IDP loaner	10/18/93	5/22/95	No	Removed 9/95
WSI 01	CART	9/18/95	3/11/96	Yes	No
25-m upwelling IR/S radiometer	CART	9/15/93	5/22/95	Yes	—
50-MHz profiler with RASS	CART	1/30/94	1/30/94	Yes	—
915-MHz profiler and RASS	CART	1/30/93	1/30/93	Yes	—
IF 915-MHz profiler and RASS	CART	9/30/96	3/31/97	No	Yes

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BLC, Belfort laser ceilometer; CART, Cloud and Radiation Testbed; EBBR, energy balance Bowen ratio; ECOR, eddy correlation; IDP, Instrument Development Program; IF, intermediate facility; IR, infrared; MFR, multifilter radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; ORR, Operational Readiness Review; PC, personal computer; RASS, radio acoustic sounding system; RCF, radiometer calibration facility; S, solar; SIROS, solar and infrared radiation observing system; SIRS, solar and infrared station; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; WSI, whole-sky imager.

TABLE A.6 Data Stream Availability as of December 31, 1996

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms				
ABRFC	sgpabrfcpcpX1.c1	R	Y	Cederwall
AERI	sgpaeri01ch1C1.a1	R	Y	Flynn
AERI	sgpaeri01ch2C1.a1	R	Y	Flynn
AERI	sgpaeri01engineerC1.a1	R	Y	Flynn
AERI	sgpaeri01summaryC1.a1	R	Y	Flynn
AERI	sgpaeriprofC1.c1	R	Y	Turner
AERI	sgpqmeaeriprofC1.c1	R	Y	Turner
AERI/LBL	sgpaerilblcloudsC1.c1	R	Y	Turner
AERI/LBL	sgpaerilbldiffC1.c1	R	Y	Turner
AERI/LBL	sgpqmeaerilblC1.c1	R	Y	Turner
AERI/LBL	sgpqmeaerimeansC1.c1	R	Y	Turner
AERI/LBL	sgpaerilbldiffssC1.c1	E	Y	Turner
AERI/LBL	sgpqmeaerilblssC1.c1	E	Y	Turner
AERI/LBL	sgpqmeaerimeanssssC1.c1	E	Y	Turner
AOS	sgpaosC1.a1	D	N	Leifer
AVHRR	sgpavhrr12radX1.a1	R	Y	Minnett
AVHRR	sgpavhrr12X1.a1	R	Y	Minnett
AVHRR	sgpavhrr14radX1.a1	R	Y	Minnett
AVHRR	sgpavhrr14X1.a1	R	Y	Minnett
BLC	sgpblcC1.a1	R	Y	Flynn
BSRN	sgpbsrnC1.a1	R	Y	Wesely
CASH	sgp07mcashX1.a1	D	N	Leach
EBBR	sgp30ebbrE12.a1	R	Y	Cook
EBBR	sgp30ebbrE13.a1	R	Y	Cook
EBBR	sgp30ebbrE15.a1	R	Y	Cook
EBBR	sgp30ebbrE20.a1	R	Y	Cook
EBBR	sgp30ebbrE22.a1	R	Y	Cook
EBBR	sgp30ebbrE26.a1	R	Y	Cook
EBBR	sgp30ebbrE4.a1	R	Y	Cook
EBBR	sgp30ebbrE7.a1	R	Y	Cook
EBBR	sgp30ebbrE8.a1	R	Y	Cook
EBBR	sgp30ebbrE9.a1	R	Y	Cook
EBBR	sgp5ebbrE*.a0	R	Y	Cook

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms (Cont.)				
ECMWF	sgpecmwfX1.00	R	—[d]	Leach
ECOR	sgp30ecorprE1.a1	E	Y	Hart
ECOR	sgp30ecorprE10.a1	E	Y	Hart
ECOR	sgp30ecorprE11.a1	E	Y	Hart
ECOR	sgp30ecorprE14.a1	E	Y	Hart
ECOR	sgp30ecorprE16.a1	E	Y	Hart
ECOR	sgp30ecorprE24.a1	E	Y	Hart
ECOR	sgp30ecorprE3.a1	E	Y	Hart
ECOR	sgp30ecorprE6.a1	E	Y	Hart
ECOR	sgp30ecorspE1.a1	E	Y	Hart
ECOR	sgp30ecorspE10.a1	E	Y	Hart
ECOR	sgp30ecorspE11.a1	E	Y	Hart
ECOR	sgp30ecorspE14.a1	E	Y	Hart
ECOR	sgp30ecorspE16.a1	E	Y	Hart
ECOR	sgp30ecorspE24.a1	E	Y	Hart
ECOR	sgp30ecorspE3.a1	E	Y	Hart
ECOR	sgp30ecorspE6.a1	E	Y	Hart
ETA	sgpalleta90X1.00	R	—	Cederwall
ETA	sgpalleta90X1.c1	D	N	Cederwall
ETA	sgpeta90X1.c1	D	N	Cederwall
ETA	sgpetaderivX1.c1	D	N	Cederwall
GOES	sgpgoes8X1.a1	R	Y	Minnett
GOES	sgpgoes8visX1.a1	R	Y	Minnett
GOES	sgpgoes8minnisX1.c1	—	—	Minnett
GOES	sgpgoes8minnis_acfX1.c1	—	—	Minnett
GOES	sgpgoeswaterX1.00	R	—	Minnett
ISM	sgp60ismX1.c1	E	Y	Cederwall
ISM	sgp30ismX1.c1	D	N	Cederwall
KSU	sgp1440ksumesoX1.a1	R	Y	Cederwall
KSU	sgp60ksumesoX1.a1	R	Y	Cederwall
LBL	sgplblch1C1.c0	R	Y	Shippert
LBL	sgplblch1C1.c1	R	Y	Shippert
LBL	sgplblch2C1.c0	R	Y	Shippert
LBL	sgplblch2C1.c1	R	Y	Shippert
LBL	sgplblch1ssC1.c0	E	Y	Shippert
LBL	sgplblch1ssC1.c1	E	Y	Shippert
LBL	sgplblch2ssC1.c0	E	Y	Shippert
LBL	sgplblch2ssC1.c1	E	Y	Shippert

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms (Cont.)				
MFR	sgpmfr10mC1.a1	B	Y	Barnard
MFR	sgpmfr25mC1.a1	B	Y	Barnard
MFRSR	sgpmfrsrC1.a0	M	Y	Barnard
MMCR	sgpmmcrcalC1.a1	E	Y	Widener
MMCR	sgpmmcrmonC1.a1	E	Y	Widener
MMCR	sgpmmcrpowC1.a1	E	Y	Widener
MPL	sgpmplC1.00	R	—	Flynn
MPL	sgpmplC1.a0	R	Y	Flynn
MWR	sgp1mwravgC1.c1	R	Y	Liljegren
MWR	sgp5mwravgB1.c1	R	Y	Liljegren
MWR	sgp5mwravgB4.c1	R	Y	Liljegren
MWR	sgp5mwravgB5.c1	R	Y	Liljegren
MWR	sgp5mwravgB6.c1	R	Y	Liljegren
MWR	sgp5mwravgC1.c1	R	Y	Liljegren
MWR	sgpmwrcalC1.c0	A	N	Liljegren
MWR	sgpmwrirtC1.a1	D	N	Liljegren
MWR	sgpmwrlosB1.a0	M	Y	Liljegren
MWR	sgpmwrlosB1.a1	R	Y	Liljegren
MWR	sgpmwrlosB4.a0	M	Y	Liljegren
MWR	sgpmwrlosB4.a1	R	Y	Liljegren
MWR	sgpmwrlosB5.a0	M	Y	Liljegren
MWR	sgpmwrlosB5.a1	R	Y	Liljegren
MWR	sgpmwrlosB6.a0	M	Y	Liljegren
MWR	sgpmwrlosB6.a1	R	Y	Liljegren
MWR	sgpmwrlosC1.a0	M	Y	Liljegren
MWR	sgpmwrlosC1.a1	R	Y	Liljegren
MWR	sgpmwrprofC1.c1	R	Y	Turner
MWR	sgpmwrtipB1.a0	M	Y	Liljegren
MWR	sgpmwrtipB4.a0	M	Y	Liljegren
MWR	sgpmwrtipB5.a0	M	Y	Liljegren
MWR	sgpmwrtipB6.a0	M	Y	Liljegren
MWR	sgpmwrtipC1.a0	M	Y	Liljegren
MWR	sgpqmemwrprofC1.c1	R	Y	Turner
MWR/LBL	sgplblmwrC1.c0	R	Y	Shippert
MWR/LBL	sgpqmemwrlblC1.c1	R	Y	Shippert
MWR/LBL	sgplblmwrssC1.c0	E	Y	Shippert
MWR/LBL	sgpqmemwrlblssC1.c1	E	Y	Shippert
MWR/sonde	sgpqmemwrcolB1.c1	R	Y	Turner
MWR/sonde	sgpqmemwrcolB4.c1	R	Y	Turner
MWR/sonde	sgpqmemwrcolB5.c1	R	Y	Turner
MWR/sonde	sgpqmemwrcolB6.c1	R	Y	Turner
MWR/sonde	sgpqmemwrcolC1.c1	R	Y	Turner

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms (Cont.)				
NWS	sgp06snwsupaX1.00	R	—	Tichler
NWS	sgp06snwsupaX1.a1	A	N	Tichler
NWS	sgp60nwssurfX1.a1	R	Y	Cederwall
NWS	sgpnwssurfX1.00	R	—	Cederwall
NWS	sgpnwsupaX1.00	R	—	Cederwall
OKM	sgp05okmX1.a1	R	Y	Cederwall
OKM	sgp15okmX1.a1	R	Y	Cederwall
Raman	sgpr1C1.a0	R	Y	Turner
Raman	sgprlprofC1.c1	D	N	Turner
Reference	refMLSspecmapX1.c1	R	—	Turner
RUC	sgpf00allruc60X1.c1	A	N	Cederwall
RUC	sgpallruc60X1.C0	E	Y	Cederwall
RUC	sgpruc60X1.c1	E	Y	Cederwall
RWP	sgp50rwptempC1.a1	R	Y	Coulter
RWP	sgp50rwptempC1.a2	R	Y	Coulter
RWP	sgp50rwpwindC1.b1	R	Y	Coulter
RWP	sgp50rwpwindC1.a1	R	Y	Coulter
RWP	sgp50rwptempC1.a2	R	Y	Coulter
RWP	sgp50rwptempC1.b1	R	Y	Coulter
RWP	sgp915rwpwindC1.a1	R	Y	Coulter
RWP	sgp915rwpwindC1.a2	R	Y	Coulter
RWP	sgp915rwptempC1.b1	R	Y	Coulter
RWP	sgp915rwpwindC1.a1	R	Y	Coutler
RWP	sgp915rwpwindC1.a2	R	Y	Coulter
RWP	sgp915rwpwindC1.b1	R	Y	Coulter
RWP	sgp915rwptempI*.*	E	Y	Coulter
RWP	sgp915rwpwindI*.*	E	Y	Coulter
RWP	sgprwptempC1.c1	S	N	Turner
SIROS	sgpsirosE1.a1	B	Y	Barnard
SIROS	sgpsirosE10.a1	B	Y	Barnard
SIROS	sgpsirosE11.a1	B	Y	Barnard
SIROS	sgpsirosE12.a1	B	Y	Barnard
SIROS	sgpsirosE13.a1	B	Y	Barnard
SIROS	sgpsirosE15.a1	B	Y	Barnard
SIROS	sgpsirosE16.a1	B	Y	Barnard
SIROS	sgpsirosE18.a1	B	Y	Barnard
SIROS	sgpsirosE2.a1	B	Y	Barnard
SIROS	sgpsirosE20.a1	B	Y	Barnard
SIROS	sgpsirosE22.a1	B	Y	Barnard
SIROS	sgpsirosE24.a1	B	Y	Barnard

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms (Cont.)				
SIROS	sgpsirosE3.a1	B	Y	Barnard
SIROS	sgpsirosE4.a1	B	Y	Barnard
SIROS	sgpsirosE5.a1	B	Y	Barnard
SIROS	sgpsirosE6.a1	B	Y	Barnard
SIROS	sgpsirosE7.a1	B	Y	Barnard
SIROS	sgpsirosE8.a1	B	Y	Barnard
SIROS	sgpsirosE9.a1	B	Y	Barnard
SIROS	sgpsirosopdepthE13.c1	D	N	Barnard
SIROS	sgpsirosopdepthE15.c1	D	N	Barnard
SIROS	sgpsirosopdepthE9.c1	D	N	Barnard
Site Operations	sgpsologB1.a0	R	Y	Tichler
Site Operations	sgpsologB4.a0	R	Y	Tichler
Site Operations	sgpsologB5.a0	R	Y	Tichler
Site Operations	sgpsologB6.a0	R	Y	Tichler
Site Operations	sgpsologC1.a0	R	Y	Tichler
Site Operations	sgpwxlogB1.a0	R	Y	Tichler
Site Operations	sgpwxlogB4.a0	R	Y	Tichler
Site Operations	sgpwxlogB5.a0	R	Y	Tichler
Site Operations	sgpwxlogB6.a0	R	Y	Tichler
Site Operations	sgpwxlogC1.a0	R	Y	Tichler
Site Operations	sgpweeksum.op	R	Y	Tichler
SMOS	sgp1smosE1.a0	R	Y	Hart
SMOS	sgp1smosE11.a0	R	Y	Hart
SMOS	sgp1smosE13.a0	R	Y	Hart
SMOS	sgp1smosE15.a0	R	Y	Hart
SMOS	sgp1smosE20.a0	R	Y	Hart
SMOS	sgp1smosE24.a0	R	Y	Hart
SMOS	sgp1smosE25.a0	R	Y	Hart
SMOS	sgp1smosE3.a0	R	Y	Hart
SMOS	sgp1smosE4.a0	R	Y	Hart
SMOS	sgp1smosE5.a0	R	Y	Hart
SMOS	sgp1smosE6.a0	R	Y	Hart
SMOS	sgp1smosE7.a0	R	Y	Hart
SMOS	sgp1smosE8.a0	R	Y	Hart
SMOS	sgp1smosE9.a0	R	Y	Hart
SMOS	sgp30smosE1.a1	R	Y	Hart
SMOS	sgp30smosE11.a1	R	Y	Hart
SMOS	sgp30smosE13.a1	R	Y	Hart
SMOS	sgp30smosE15.a1	R	Y	Hart
SMOS	sgp30smosE20.a1	R	Y	Hart
SMOS	sgp30smosE24.a1	R	Y	Hart
SMOS	sgp30smosE25.a1	R	Y	Hart
SMOS	sgp30smosE3.a1	R	Y	Hart
SMOS	sgp30smosE4.a1	R	Y	Hart
SMOS	sgp30smosE5.a1	R	Y	Hart

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Currently Operating Platforms (Cont.)				
SMOS	sgp30smosE6.a1	R	Y	Hart
SMOS	sgp30smosE7.a1	R	Y	Hart
SMOS	sgp30smosE8.a1	R	Y	Hart
SMOS	sgp30smosE9.a1	R	Y	Hart
Sonde	sgpobjsondprof.c1	E	N	Leach
Sonde	sgpsondewndcalcB1.c1	R	Y	Leach
Sonde	sgpsondewndcalcB4.c1	R	Y	Leach
Sonde	sgpsondewndcalcB5.c1	R	Y	Leach
Sonde	sgpsondewndcalcB6.c1	R	Y	Leach
Sonde	sgpsondewndcalcC1.c1	R	Y	Leach
Sonde	sgpsondewrpnB1.a1	R	Y	Lesht
Sonde	sgpsondewrpnB4.a1	R	Y	Lesht
Sonde	sgpsondewrpnB5.a1	R	Y	Lesht
Sonde	sgpsondewrpnB6.a1	R	Y	Lesht
Sonde	sgpsondewrpnC1.a1	R	Y	Lesht
Sonde/LBL	sgplblsondeC1.c1	E	Y	Shippert
SORTI	sgpsortiC1.a1	D	N	Flynn
SWATS	sgpswatsE*.a1	D	N	Schneider
Tower	sgp1twr25mC1.a0	R	Y	Cook
Tower	sgpltwr60mC1.a0	R	Y	Cook
Tower	sgp30twr25mC1.a1	R	Y	Cook
Tower	sgp30twr60mC1.a1	R	Y	Cook
Vceil	sgpvceil75kC1.a0	R	Y	Flynn
WPDN	sgp06wpdnmmtsX1.a1	R	Y	Leach
WPDN	sgp06wpdnrassX1.a1	D	N	Leach
WPDN	sgp30wpdngpsX1.c1	R	Y	Liljegren
WPDN	sgp60wpdnmmtsX1.a1	S	N	Leach
WPDN	sgp60wpdnrassX1.b1	R	Y	Leach
WPDN	sgp60wpdnsurfX1.b1	R	Y	Leach
WPDN	sgp60wpdnwndsX1.b1	R	Y	Leach
WSI	sgpwsiC1.a1	E	Y	Tooman
WSI	sgpwsicldfracC1.a1	E	Y	Tooman
WSI	sgpwsiimageC1.a1	E	Y	Tooman
WSI	sgpwsiqcC1.a1	E	Y	Tooman

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Defunct Platforms				
AERI	sgpaerich1C1.a1	DR	N	Turner
AERI	sgpaerich2C1.a1	DR	N	Turner
AERI	sgpaerisummaryC1.a1	DR	N	Turner
AERI	sgpaerich1C1.a2	DR	N	Turner
AERI	sgpaerich2C1.a2	DR	N	Turner
AERI	sgpaerisummmaryC1.a2	DR	N	Turner
AERI	sgpaeridqflagC1.c1	DND	N	Turner
AVHRR	sgpavhrrX1.b1	DU	N	Liljegren
AVHRR	sgpavhrr9radX1.a1	DU	N	Minnett
AVHRR	sgpavhrr9X1.a1	DU	N	Minnett
BSRN	sgpbsrncalcC1.c1	DU	N	Shippert
Cess algorithm	sgp1toacessC1.c1	DU	N	Shippert
GOES	sgpgoesirX1.b1	DR	N	Liljegren
GOES	sgpgoesvisX1.b1	DR	N	Liljegren
GOES	sgpgoes7ir8X1.a1	DR	N	Minnett
GOES	sgpgoes7minnisX1.c1	DU	N	Minnis
GOES	sgpgoes7minnis_acfX1.c1	DU	N	Minnis
GOES	sgpgoes7rad8X1.a1	DR	N	Minnett
GOES	sgpgoes7radX1.a1	DR	N	Minnett
GOES	sgpgoes7visX1.a1	DR	N	Minnett
KSU	sgpksudlymesoX1.b1	DNR	N	Tichler
KSU	sgpksuhrlymesoX1.b1	DNR	N	Tichler
MAPS	sgpmaps60derivX1.c1	DU	N	Cederwall
MAPS	sgpmaps60X1.c1	DU	N	Cederwall
MAPS	sgpmapsall60X1.c1	DU	N	Cederwall
MPL	sgpmplcbhC1.c1	DR	N	Scott
MWR	sgpmwrtipC1.a1	DU	N	Liljegren
NGM	sgpngm250derivX1.c1	DU	N	Cederwall
NGM	sgpngm250X1.c1	DU	N	Cederwall
Sonde	sgpsondeB1.a1	DR	N	Lesht
Sonde	sgpsondeB4.a1	DR	N	Lesht
Sonde	sgpsondeB5.a1	DR	N	Lesht
Sonde	sgpsondeB6.a1	DR	N	Lesht
Sonde	sgpsondeC1.a1	DR	N	Lesht
Sonde	sgpsondenogcwrpnC1.c1	DU	N	Shippert

TABLE A.6 (Cont.)

Base[a]	Data Stream	Availability[b]	Ingested[c]	Quality Contact
Defunct Platforms (Cont.)				
Tower	sgp1twr21xC1.a0	DR	N	Cook
Tower	sgp30twr21xC1.a1	DR	N	Cook
WSI	sgpwsicloudC1.b1	D	N	Thorne
WSI	sgpwsicloudC1.c1	D	N	Thorne

[a] Bases: ABRFC, Arkansas Basin Red River Forecast Center; AERI, atmospherically emitted radiance interferometer; AOS, aerosol observation system; AVHRR, advanced very-high-resolution radiometer; BLC, Belfort laser ceilometer; BSRN, Baseline Surface Radiation Network; CASH, commercial aviation sensing humidity; Cess, R. Cess, State University of New York; EBBR, energy balance Bowen ratio; ECMWF, European Centre for Medium Range Weather Forecasts; ECOR, eddy correlation; ETA, National Centers for Environmental Prediction model; GOES, geostationary orbiting Earth satellite; ISM, Integrated Surface Mesonet; KSU, Kansas State University; LBL, line by line; MAPS, Mesoscale Analysis and Prediction System; MFR, multifilter radiometer; MFRSR, multifilter rotating shadowband radiometer; MMCR, millimeter cloud radar; MPL, micropulse lidar; MWR, microwave radiometer; NGM, nested grid model; NWS, National Weather Service; OKM, Oklahoma Mesonet; RUC, rapid update cycle; RWP, radar wind profiler; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station; SORTI, solar radiance transmission interferometer; SWATS, soil water and temperature system; Vceil, Vaisala ceilometer; WPDN, Wind Profiler Demonstration Network; WSI, whole-sky imager.

[b] Availability: A, analysis; B, beta release; D, developmental; DND, defunct, no data; DR, defunct, releasable; DU, defunct, unknown; E, evaluation; M, mentor only; R, releasable; S, suspended.

[c] Y, yes; N, no.

[d] Information unavailable.

APPENDIX B:

OBSERVATIONS, MEASUREMENTS,

AND EXTERNAL DATA

TABLE B.1 CART Observation Status on December 31, 1996[a,b]

Observation	Platform
From the AERI	
Wave number (520-1800 cm^{-1})	sgpaeri01ch1C1.al
Mean IR radiance spectra ensemble	sgpaeri01ch1C1.al
Standard deviation of spectra ensemble	sgpaeri01ch1C1.a1
Wave number (1800-3020 cm^{-1})	sgpaeri01ch2C1.a1
Mean IR radiance spectra ensemble	sgpaeri01ch2C1.al
Standard deviation of spectra ensemble	sgpaeri01ch2C1.al
Mean IR radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
Standard deviation of the radiance at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
Brightness temperature at 675-680, 700-705, 985-990, 2295-2300, 2282-2287, and 2510-2515 cm^{-1}	sgpaeri01summaryC1.al
From the BBSS	
Sonde temperature profile	sgpsondewrpn*.al
Sonde relative humidity profile	sgpsondewrpn*.al
Sonde pressure profile	sgpsondewrpn*.al
Sonde wind speed profile	sgpsondewrpn*.al
Sonde wind direction profile	sgpsondewrpn*.al
From the BLC	
Cloud base height at three levels	sgpblcC1.c1
From the BSRN	
Direct beam-normal solar radiance	sgpbsrnC1.a1
Downwelling hemispheric diffuse solar radiance	sgpbsrnC1.a1
Downwelling hemispheric solar irradiance	sgpbsrnC1.a1
Downwelling hemispheric IR radiance	sgpbsrnC1.a1
From the EBBR (at 10 Sites)	
Sensible heat flux	sgp30ebbrE*.al
Latent heat flux	sgp30ebbrE*.al
Net radiation	sgp30ebbrE*.al
Average soil heat flow	sgp30ebbrE*.al
Top and bottom air temperatures	sgp30ebbrE*.al
Top and bottom relative humidities	sgp30ebbrE*.al
Top and bottom vapor pressures	sgp30ebbrE*.al
Atmospheric pressure	sgp30ebbrE*.al
Soil moistures at five points	sgp30ebbrE*.al
Soil temperatures at five points	sgp30ebbrE*.al
Soil heat flow from plates at five points	sgp30ebbrE*.al
Soil heat flow at five points	sgp30ebbrE*.al
Scalar and resultant wind speeds	sgp30ebbrE*.al
Mean and standard deviation of wind direction	sgp30ebbrE*.al
Change in soil energy storage at five points	sgp30ebbrE*.al

TABLE B.1 (Cont.)

Observation	Platform
From the EBBR (at 10 Sites) (Cont.)	
Reference temperature	sgp30ebbrE*.al
Bowen ratio	sgp30ebbrE*.al
Soil heat flow at surface at five points	sgp30ebbrE*.al
From the MFR	
10-m upwelling hemispheric irradiance (414, 500, 609, 665, 860, and 938 nm)	sgpmfr10mC1.a1
10-m upwelling broadband hemispheric irradiance	sgpmfr10mC1.a1
25-m upwelling hemispheric irradiance (414, 500, 609, 861, and 938 nm)	sgpmfr25mC1.a1
25-m upwelling broadband hemispheric irradiance	sgpmfr25mC1.a1
25-m upwelling longwave hemispheric irradiance	sgpmfr25mC1.a1
25-m upwelling shortwave hemispheric irradiance	sgpmfr25mC1.a1
From the MPL	
Cloud base height	sgpmplC1.a0
From the MWR (5 at CF and BFs)	
Column-integrated precipitable water vapor	sgpmwrlos*.al
Column-integrated liquid water path	sgpmwrlos*.al
23.8-GHz brightness temperature	sgpmwrlos*.al
31.4-GHz brightness temperature	sgpmwrlos*.al
IR (9.7-11.6 µm) sky temperature	sgpmwrlos*.al
From the Profiling Radars	
915-MHz wind speed profile	sgp915rwpwindC1.b1
915-MHz wind direction profile	sgp915rwpwindC1.b1
915-MHz virtual temperature profile	sgp915rwptempC1.b1
50-MHz wind speed profile	sgp50rwpwindC1.b1
50-MHz wind direction profile	sgp50rwpwindC1.b1
50-MHz virtual temperature profile	sgp50rwptempC1.b1
From the SMOS (at 14 EFs)	
Mean and standard deviation of wind speed	sgp30smosE*.al
Mean and standard deviation of wind direction	sgp30smosE*al
Vector-averaged wind speed	sgp30smosE*.al
Mean and standard deviation of temperature	sgp30smosE*.al
Mean and standard deviation of relative humidity	sgp30smosE*.al
Vapor pressure	sgp30smosE*.al
Mean and standard deviation of barometric pressure	sgp30smosE*.al
Snow depth	sgp30smosE4.al
Precipitation total	sgp30smosE4.al

TABLE B.1 (Cont.)

Observation	Platform
From the SIROS (at 17 EFs)	
Upwelling longwave hemispheric irradiance	sgpsirosE*.al
Downwelling longwave diffuse hemispheric irradiance	sgpsirosE*.al
Upwelling shortwave hemispheric solar irradiance	sgpsirosE*.al
Downwelling shortwave diffuse hemispheric irradiance	sgpsirosE*.al
Shortwave direct normal irradiance	sgpsirosE*.al
Hemispheric downward solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Hemispheric downward total solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Diffuse hemispheric downward solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Diffuse hemispheric downward total solar irradiance	sgpsirosE*.al
Direct beam-normal solar irradiance (415, 499, 608, 664, 860, and 938 nm)	sgpsirosE*.al
Direct beam-normal total solar irradiance	sgpsirosE*.al
From the Tower	
Mean and standard deviation of temperature, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of relative humidity, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of vapor pressure, 25 m	sgp30twr25mC1.a1
Mean and standard deviation of temperature, 60 m	sgp30twr25mC1.a1
Mean and standard deviation of relative humidity, 60 m	sgp30twr25mC1.a1
Mean and standard deviation of vapor pressure, 60 m	sgp30twr25mC1.a1

[a] AERI, atmospherically emitted radiance interferometer; BBSS, balloon-borne sounding system; BF, boundary facility; BLC, Belfort laser ceilometer; BSRN, Baseline Surface Radiation Network; CF, central facility; EBBR, energy balance Bowen ratio; EF, extended facility; IR, infrared; MFR, multifilter radiometer; MPL, micropulse lidar; MWR, microwave radiometer; SIROS, solar and infrared radiation observing system; SMOS, surface meteorological observation station.

[b] All the data are available.

TABLE B.2 CART-Derived Measurement Status on December 31, 1996[a,b]

Measurement	Platform
Retrieved absolute temperature profile	sgpaeriprofC1.c1
Retrieved dew point temperature profile	sgpaeriprofC1.c1
Retrieved water vapor mixing ratio profile	sgpaeriprofC1.c1
Comparisons of AERI retrieved profiles with radiosonde observation (retrieval - sonde)	sgpqmeeariprofC1.c1
Comparisons of AERI retrieved profiles with tower *in situ* measurements (retrieval - sonde)	sgpqmeeariprofC1.c1
Differences of observations and calculations of profiles (AERI retrieval - sonde)	sgpqmeaeriprofC1.c1
Integrated precipitable water vapor (from sonde)	sgpaerilblcloudsC1.c1
Cloud base height estimates (2)	sgpaerilblcloudsC1.c1
Nonclear sky flag at AERI sample times	sgpaerilblcloudsC1.c1
Differences of observations and calculation of IR radiances (AERI - LBLRTM) and supporting statistical summaries	sgpaerilbldiffC1.c1 sgpaerilblC1.c1 sgpaerimeansC1.c1
Input for LBLRTM (rundecks 550-1799 cm^{-1})	sgplblch1C1.c0
Input for LBLRTM (rundecks 1800-3020 cm^{-1})	sgplblch2C1.c0
Output of LBLRTM (IR spectral radiance 550-1799 cm^{-1})	sgplblch1C1.C1
Output of LBLRTM (IR spectral radiance 1800-3020 cm^{-1})	sgplblch2C1.C1
Average (1-min) 23.8-GHz brightness temperature (CF only)	sgp1mwravgC1.c1
Average (1-min) 31.4-GHz brightness temperature (CF only)	sgp1mwravgC1.c1
Average (1-min) column-integrated water vapor (CF only)	sgp1mwravgC1.c1
Average (1-min) column-integrated liquid water (CF only)	sgp1mwravgC1.c1
Average (1-min) IR brightness temperature (CF only)	sgp1mwravgC1.c1
Average (5-min) 23.8-GHz brightness temperature (CF and BFs)	sgp5mwravg*.c1
Average (5-min) 31.4-GHz brightness temperature (CF and BFs)	sgp5mwravg*.c1
Average (5-min) column-integrated water vapor (CF and BFs)	sgp5mwravg*.c1
Average (5-min) column-integrated liquid water (CF and BFs)	sgp5mwravg*.c1
Average (5-min) IR brightness temperature (CF and BFs)	sgp5mwravg*.c1
Retrieved absolute temperature profile	sgpmwrprofC1.c1
Retrieved water vapor density profile	sgpmwrprofC1.c1
Retrieved cloud liquid water content profile	sgpmwrprofC1.c1
Retrieved columnar water vapor	sgpmwrprofC1.c1
Retrieved columnar liquid water	sgpmwrprofC1.c1

TABLE B.2 (Cont.)

Measurement	Platform
Comparisons of MWR retrieved profiles with radiosonde observations (retrieval - sonde)	sgpqmemwrprofC1.c1
Differences of observations and calculations of profiles (MWR retrieval - sonde)	sgpqmemwrprofC1.c1
Input for LBLRTM (rundecks 23.8 and 31.4 GHz)	sgplblmwrC1.c0
Calculated 23.8-GHz brightness temperature	sgpqmemwrlblC1.c1
Calculated 31.4-GHz brightness temperature	sgpqmemwrlblC1.c1
Averaged total water vapor along path	sgpqmemwrlblC1.c1
Integrated vapor column from sonde (using MWR IPM)	sgpqmemwrcol*.c1
Integrated vapor column from sonde (direct calculation)	sgpqmemwrcol*.c1
23.8-GHz brightness temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
31.4-GHz brightness temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
Atmospheric mean radiating temperature using sonde (MWR IPM)	sgpqmemwrcol*.c1
Merged virtual temperature profile from 915- and 50-MHz RASS	sgprwptempC1.c1
Data quality profile for the virtual temperature	sgprwptempC1.c1
Calculated W to E component of wind	sgpsondewndcalc*.c1
Calculated S to N component of wind	sgpsondewndcalc*.c1
Scaled water vapor profile from the sondes to match 23-GHz line strength measured by MWR	sgplblsondeC1.c1
Combined surface meteorology from five platforms into 60-min averaged data sets. The platforms that are combined are the ARM SMOS, Kansas Mesonet, NWS Surface Stations, Oklahoma Mesonet, and WPDN Surface Stations. The data are linearly averaged hourly, for subhourly values, from the previous hour. Currently, a maximum of 349 stations are included in the domain, defined by the WPDN. The meteorological data include precipitation, relative humidity, temperature, winds, and barometric pressure.	sgp60ismX1

[a] AERI, atmospherically emitted radiance interferometer; ARM, Atmospheric Radiation Measurement; BF, boundary facility; CF, central facility; IPM, instrument performance model; IR, infrared; LBLRTM, line-by-line radiative transfer model; MWR, microwave radiometer; NWS, National Weather Service; RASS, radio acoustic sounding system; SMOS, surface meteorological observation station; WPDN, Wind Profiler Demonstration Network.

[b] All the data are available.

TABLE B.3 CART External Data Status on December 31, 1996[a,b]

Measurement	Platform
From Satellites	
AVHRR channel 1 "albedo," channel 2 "albedo," channel 3 brightness temperature, channel 4 brightness temperature, channel 5 brightness temperature, satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpavhrrnnX1.a1[c]
AVHRR radiances: channel 3 calibrated radiances, channel 4 calibrated radiances, and channel 5 calibrated radiances	sgpavhrrnnradX1.a1
AVHRR coastlines and rivers	avhrr_sgp.rivers
AVHRR state lines	avhrr_sgp.state_lines
AVHRR annotated latitude and longitude	avhrr_sgp.lat_lon
GOES-8[d,e] visible: visible channel "albedo," satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpgoes8visX1.a1
GOES-8[f] channel 1 "albedo," channel 2 brightness temperature, channel 4 brightness temperature, channel 5 brightness temperature, satellite-solar azimuth angle, satellite zenith angle, and solar zenith angle	sgpgoes8X1.a1
GOES (4-km) coastlines and rivers	goes_ir_sgp.rivers
GOES (4-km) state lines	goes_ir_sgp.state_lines
GOES (4-km) annotated latitude and longitude	goes_ir_sgp.lat_lon
GOES (1-km) coastlines and rivers	goes_vis_sgp.rivers
GOES (1-km) state lines	goes_vis_sgp.state_lines
GOES (1-km) annotated latitude and longitude	goes_vis_sgp.lat_lon
From GOES Data	
GOES-derived products: cloud amount (low, medium, and high), visible optical depth (low, medium, and high), IR optical depth (low, medium, and high), emissivity (low, medium, and high), cloud center height (low, medium, and high), cloud top height (low, medium, and high), cloud temperature (low, medium, and high), cloud thickness (low, medium, and high), reflectance (low, medium, and high), albedo (low, medium, and high), cloud center temperature (low, medium, and high), cloud top temperature (low, medium, and high), visible optical depth standard deviation (low, medium, and high), cloud center temperature standard deviation (low, medium, and high), broadband longwave flux (clear sky and total), narrowband IR flux (clear sky and total), broadband shortwave albedo (clear sky and total), narrowband visible albedo (clear sky and total), clear temperature, clear temperature standard deviation, narrowband visible albedo standard deviation, clear visible reflectance, and solar zenith angle	sgpgoes8minnisX1.c1 (covers area at 32-42° N, with 0.5° resolution) sgpgoes8minnis_acfX1.c1 (a 3 × 3 array of 0.3 resolution pixels centered on central facility)
Soundings of dew point and temperature over the SGP CART site, derived from GOES8 soundings at the University of Wisconsin, CIMSS/SSEC.	sgpgoeswaterX1

TABLE B.3 (Cont.)

Measurement	Platform
From the National Centers for Environmental Prediction (NCEP) RUC Model	
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 hPa from the surface to 100 hPa, covering most of North America (subsets also available)	sgpf00allruc60X1.c1
Gridded meteorological fields (eight daily) of height, temperature, relative humidity, and horizontal wind components, every 25 hPa from the surface to 100 hPa, covering most of the SGP CART site	sgpallruc60X1.c1
Derived variables from RUC data, similar to those in ngm250derived	sgpruc60derivX1.c1
From the Arkansas Basin Red River Forecast Center	
Hourly precipitation estimates for an area much larger than the SGP CART site, at 4-km resolution	sgpabrfcpcpX1.c1
From the NCEP ETA Model	
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 hPa from the surface to 100 hPa, covering most of North America (subsets also available)	sgpalleta90X1.c1
Gridded meteorological fields (four daily) of height, temperature, relative humidity, and horizontal wind components, every 50 hPa from the surface to 100 hPa, covering most of the SGP CART site	sgpeta90X1.c1
Horizontally averaged values, derived from eta90 data, of surface pressure (reduced to sea level), tropopause pressure, and surface temperature	eta90derived
Slab-averaged vertical profiles, derived from eta90 data, of temperature (T), -(u*dT/dx + v*dT/dy), water vapor mixing ratio (q), -(u*dq/dx + v*dq/dy), horizontal wind components (u and v), (du/dx + dv/dy), -(u*du/dx + v*du/dy), - (u*dv/dx + v*dv/dy), and geopotential height (Z), dZ/dx, dZ/dy, d2T/dx2, d2T/dy2, d2q/dx2, d2q/dy2, d2u/dx2, d2u/dy2, d2v/dx2, d2v/dy2	eta90derived
From the NOAA Wind Profiler Demonstration Network	
Profile of hourly consensus wind components	sgp60wpdnwndsX1.b1
Profile of 6-min moments of wind components	sgp06wpdnmmtsX1.a1
Hourly surface observations	sgp60wpdnsurfX1.b1
Profile of 6-min moments of temperature components	sgp06wpdnrassX1.00
Profile of hourly consensus of temperature with RASS capability	sgp60wpdnrassX1.00
Precipitable water vapor from stations which have GPS systems	sgp30wpngps.c1

TABLE B.3 (Cont.)

Measurement	Platform
From the ECMRWF	
Grid: Quantities listed are averaged over three longitude and latitude domains. They are 260.3, 38.8, 264.6, 34.8; 261.7, 34.8, 263, 34.2; 261.7, 37, 263, 36.	sgpecmwfX1
Gridded measurements are p - pressure (Pa); u - zonal wind component (m/s); v - meridional wind component (m/s); T - temperature (K); q - specific humidity (kg/kg); l - specific cloud liquid water content (kg/kg); i - specific cloud ice content (kg/kg); a - cloud refraction (percent/100); R - relative humidity (percent/100); w - omega = vertical velocity in pressure coordinates (Pa/s); fswr - net shortwave flux (W/m^2); flwr - net longwave flux (W/m^2); and total and physical tendencies for u, v, T, and q on the 31 model levels ($W/m^2/s$).	sgpecmwfX1
From the NWS	
Surface hourly observations	sgp60nwssurfX1.a1
Upper air observations	sgpnwsupaX1.00
Six-second resolution soundings	sgp06snwsupaX1
From the Kansas Surface Mesonetwork	
Daily observations of maximum air temperature, minimum air temperature, total precipitation, total solar radiation, maximum 5-cm soil temperature, minimum 5-cm soil temperature, maximum 10-cm soil temperature, minimum 10-cm soil temperature, average relative humidity, maximum relative humidity, minimum relative humidity, mean wind speed, resultant wind speed, resultant direction, standard deviation of direction, and maximum (fastest minute) wind speed	sgp1440ksumesoX1.a1
Hourly observations of average temperature, average relative humidity, average wind speed, average wind direction, average solar radiation, total precipitation, average 10-m temperature	sgp60ksumesoX1.a1
From the Oklahoma Mesonetwork	
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (15-min average)	sgp15okmX0.a0

TABLE B.3 (Cont.)

Measurement	Platform
From the Oklahoma Mesonetwork (Cont.)	
Observations of air temperature, relative humidity, wind direction, wind speed, total solar radiance, total rainfall, and 5- and 10-cm soil temperatures (5-min average)	sgp05okmX0.a0

[a] AVHRR, advanced very-high-resolution radiometer; CART, Cloud and Radiation Testbed; CIMSS/SSEC, Cooperative Institute for Meteorological Satellite Studies/Space Science and Engineering Center; ECMRWF, European Centre for Medium Range Weather Forecasting; ETA, National Centers for Environmental Prediction model; GOES, geostationary orbiting Earth satellite; GPS, global positioning system; IR, infrared; NCEP, National Centers for Environmental Prediction; NOAA, National Oceanic and Atmospheric Administration; NWS, National Weather Service; RASS, radio acoustic sounding system; RUC, rapid update cycle; SGP, Southern Great Plains.

[b] All the data are available.

[c] The "nn" in the "avhrnn" file name is the sequence number for the NOAA satellite (e.g., NOAA-12 or NOAA-14).

[d] The GOES IR channels may vary with the schedule for use at a particular time.

[e] The resolution of these data is 1 km, and the area covered is 33.68 to 39.42°N, 95.43 to 99.43°W.

[f] The resolution of these data is 4 km, and the area covered is 24.33 to 47.26°N, 89.65 to 105.31°W.